

Attachment Q

STATE OF KANSAS

DEPARTMENT OF HEALTH and ENVIRONMENT



**MINIMUM STANDARDS OF DESIGN
FOR
WATER POLLUTION CONTROL FACILITIES**

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FOREWORD

This document is the second version of the "Minimum Standards of Design for Water Pollution Control Facilities". The revisions to the document have been made in response to the considerable input received during the first two years of the document's use, the changing nature of wastewater technology, and the errors and oversights of the original document.

As with the original "Minimum Standards", this document is developed pursuant to K.S.A. 65-171h wherein the Kansas Department of Health and Environment is authorized to develop, assemble, compile, approve, and publish minimum standards of design for design and construction of sewage systems.

The standards in general indicate required minimum and maximum design requirements. The standards have been based on generally accepted engineering practices, textbooks and literature in the wastewater field, and the experience of Bureau of Water Quality staff. In many cases, the requirements in this document may be waived upon presentation of sufficient justification for such deviation by the design engineer or system owner. This document is not intended to restrict development or innovative ideas or to hinder the use of new products.

As with the previous document, the current document will be subject to periodic revision. It is anticipated that revisions will be kept relatively current, and that the revisions will be made on a chapter by chapter basis, with mailings to those persons or companies on the mailing list.

TABLE OF CONTENTS

	<u>PAGE</u>
I. FACILITIES PLAN	
A. Introduction	1
B. Where Required	1
C. Propose	1
D. Relation to Water Quality Management Plans	1
E. Regionalization	1
F. Environmental Compatibility	2
G. Contents of the Facilities Plan	2
H. Federal Grant Projects	5
I. Professional Engineer's Seal	6
II. PRE-DESIGN CONFERENCE	
A. Requirements	1
B. Scheduling	1
C. Purpose	1
D. Topics to be Discussed	1
III. PLAN AND SPECIFICATION PRESENTATION	
A. Plans	1
B. Specifications	3
C. Revision to Plans and/or Specifications	3
D. Design Calculations and Parameters	3
E. Plan and Specification - Effective Period	4
F. Record Plans	4
IV. GENERAL DESIGN CONSIDERATIONS FOR SEWAGE TREATMENT WORKS	
A. Introduction	1
B. Degree of Treatment	1
C. Plant Location	1
D. Separation Requirements	1
E. Fencing	3
F. Design Considerations	3
G. Plant Details	5
H. Flow Measurement	7
I. Sludge Handling and Disposal	9
J. Safety Features	10
K. Emergency Operation	11
V. SOILS	
A. Introduction	1
B. Compaction Requirements	1
C. Soils Analysis for Earthen Structures	1
D. Presentation of Data	4
VI. SANITARY SEWER DESIGN	
A. Type of Sewers	1
B. Design Period	1
C. Design Basis	1
D. Details of Design, Construction and Materials	2
E. Acceptance Tests for Sewers	8

	<u>PAGE</u>
F. Manholes	9
G. Cleanouts and Lampholes	14
H. Protection of Water Supplies	14
I. Outfall Sewers	14
 VII. SEWAGE PUMPING STATIONS	
A. General	1
B. Type and Capacity	1
C. Structures	1
D. Pumps	2
E. Force Mains and Piping	4
F. Power Supply	5
G. Alarm System	5
H. Ventilation	5
 VIII. PRIMARY TREATMENT	
A. Definition	1
B. Screening	1
C. Grit Removal Facilities	2
D. Pre-Aeration and Flocculation	4
E. Sedimentation Basins	5
 IX. MECHANICAL BIOLOGICAL TREATMENT	
A. Trickling Filters	1
B. Activated Sludge	5
C. Aeration Equipment	10
D. Oxidation Ditches	12
E. Rotating Biological Discs	15
F. Final or Secondary Sedimentation Tanks	16
 X. WASTE STABILIZATION PONDS	
A. General	1
B. Anaerobic Ponds	2
C. Aerobic or Faculative Waste Stabilization Ponds	4
D. Aerated Ponds	6
E. Pond Construction Details	7
 XI. SLUDGE DIGESTION AND PROCESSING	
A. Anaerobic Sludge Digestion	1
B. Aerobic Sludge Digestion	6
C. Sludge Pumps and Piping	8
D. Sludge Dewatering	9
E. Digested Sludge Ponds	10
F. Mechanical Dewatering Facilities	11
G. Drainage and Filtrate Disposal	11
H. Final Disposal of Sludge	11
I. Incineration	12
 XII. DISINFECTION	
A. Purpose	1
B. Where Required	1
C. Methods of Disinfection	1
D. Deviations	1

	<u>PAGE</u>
E. Chlorination Facilities and Equipment	1
F. Reliability	6
G. Dechlorination	6
H. Operation and Maintenance	6
 XIII. AGRICULTURAL APPLICATION OF WASTEWATER OR SLUDGE	
Introduction	1
Minimum Design Requirements	2
A. Site Considerations	2
B. Storage and Application of Wastewater Sludges	3
C. Application of Wastewater Effluent for Treatment and Irrigation Oriented Systems	3
D. Storage and Application of Wastewater Effluent for Treatment Oriented Systems Only	4
Engineering Report	4
A. Evaluation of Wastewater and Sludge Characteristics	4
B. Site Considerations	5
C. Wastewater Effluent Land Application Considerations	7
D. Considerations for Land Application of Sludges	10
Appendix	13
 XIV. LABORATORY REQUIREMENTS	
A. Requirement for Laboratories	1
B. General Laboratory Considerations	1
C. Analyses	1
D. General Laboratory Design	1
E. Design Recommendations	5

I. FACILITIES PLAN

A. Introduction

1. The facilities plan is a comprehensive engineering report in which all controlling factual information, design factors, and assumptions are examined and recorded.
2. Within the scope of the facilities plan, the engineer should assemble all basic information necessary for the design of the treatment works. Treatment works shall be defined as follows: "the collection system and/or the facility or group of units provided for the transportation and treatment of domestic, commercial, or industrial wastewater".

B. Where Required

1. A facilities plan shall be prepared for all new wastewater treatment works and all major modifications to existing wastewater treatment works. Sewer extensions shall be excluded.

C. Purpose

1. The purpose of the facilities plan is to present the findings of the engineer in a precise fashion with enough attention given to detail so as to allow adequate review of the project by the owner and applicable regulatory agencies. The plan will allow the review of the alternatives from the viewpoints of function, operation, economics, reliability, safety, and efficiency.

D. Relation to Water Quality Management Plans

1. The completed facilities plan shall be in conformance with approved water quality criteria and basin management plans.
2. Projects developed within metropolitan planning areas shall be in conformance with section 208, Public Law 92-500 planning requirements.

E. Regionalization

1. Regionalization of water pollution control systems shall be practiced when technically feasible and cost effective. New subdivisions, mobile home parks, industries, and other developments shall utilize existing water pollution control facilities wherever and whenever possible. Regionalization considerations should reflect the items mentioned above where applicable. The facilities plan shall contain the information specified in section G.1.c. of this chapter.

F. Environmental Compatibility

1. The alternatives examined in the facilities plan must be evaluated in terms of net environmental effect. Care should be taken that pollutants addressed are germane to the local water quality problem and that abatement practices utilized do not shift an environmental problem in one area to another area.
2. Water pollution control facilities should, to the maximum degree feasible, be made compatible with the immediate physical setting of the plant site.
3. Efforts shall be taken to preserve natural beauty, wildlife, recreational areas, historic sites, and private property.

G. Contents of the Facilities Plan

1. As a minimum, the facilities plan shall include:
 - a. The existing population or waste load and the projected population(s) or waste load(s) for the established design life and/or phases of the project. Industrial waste load input to municipal systems should be addressed in detail. The normally accepted design life is 20 years. Existing and design year land use patterns should be estimated and discussed in relation to the project. Existing land zoning and planning requirements should also be ascertained and discussed.
 - b. A detailed description of the location, including maps, of the project with regard to adjacent habitation, property lines, elevations, and topographic features within one-half mile of the proposed site(s).
 - c. The location and a general description of all municipal, commercial, industrial, or agricultural treatment facilities, subdivisions, septic tank areas, or other wastewater sources within a two mile radius of the existing or proposed treatment facility shall be included in the facilities plan.
 - d. A description of the receiving watercourse, flood elevation (new facilities - 100 year frequency; existing facilities - 50 year frequency), and the expected impact on the existing water quality. The location, within one-half mile of the proposed site, and type of the nearest water supply(s), (wells or surface supply), if any, should be noted. The engineer should also determine if the Division of Water Resources, Kansas Department of Agriculture or the U.S. Army Corps of Engineer's regulatory requirements are applicable to the project site.
 - e. A description of the existing treatment works including individual unit design capacities and physical condition.

- f. A detailed description of each alternative being considered. The description should include to the extent appropriate information such as service area, schematic flow diagrams, unit processes, unit sizing, preliminary design parameters, soils information*, etc. This information shall also be supplied for the alternative selected for eventual construction.

*If the project involves lagoon structures and treatment processes, a detailed soils investigation of the proposed site(s) will be addressed in the plan or prior to design. (See the chapter entitled "Soils" for detailed soils considerations requirements).

1. One of the alternatives addressed should be an evaluation of improved effluent quality attainable by upgrading the operation, maintenance and efficiency of existing facilities.
 2. Each alternative should be evaluated for its capability to meet applicable effluent limitations and water quality standards. The treatment works design must be based upon not less than secondary treatment as defined by the U.S. Environmental Protection Agency or BPWTT for industrial situations. Where application of secondary treatment or BPWTT would not meet State water quality standards, the facilities plan shall provide for attaining such standards. Such provision shall consider treating combined sewer overflows as an alternative means of meeting water quality standards.
- g. The quantity, quality, and ultimate disposal of the expected wastewater sludges should be addressed.
- h. Existing public wastewater facilities shall be sampled and have adequate flow measurement data. The following minimum information shall be provided:
1. Two (2) 24-hour composite samples with composite intervals no longer than three (3) hours.
 2. Where wastewater strength and/or flow is subject to rapid variations, a minimum of 24 consecutive grab samples taken at one hour intervals shall be examined and analyzed. An automatic sequential sampler is recommended.
 3. BOD₅, Total Suspended Solids, pH, and temperature analyses will be provided as a minimum.
 4. Projects concerning industrial and/or commercial facilities will provide adequate sample and analysis data to sufficiently characterize the wastewater in question, and to determine possible treatment alternatives.

5. Flow measurement data, water use data, or other information concerning wastewater volume and frequency of flow should be provided in sufficient detail to allow establishment of design flow. As a minimum, two (2) weeks of continuously recorded flow measurement must be provided in appropriate locations for facilities involving existing sewer systems to provide a basis for design and to quantify infiltration and inflow. In larger systems, consideration must be given to flow measurement of sewer subsystems.
 6. Per capita design wastewater flows as low as 75 gallons per capita per day may be utilized. Per capita design wastewater flows as low as 60 gallons per capita per day may be utilized if sufficient data is submitted to justify the design flow. Approval will not be given to per capita design wastewater flows of less than 60 gallons per capita per day. This requirement does not apply to industries, highway rest stops, recreational facilities, and other similar locations with unique wastewater production patterns. If the design for the water pollution control facility is hydraulically dependent, as in the case of non-overflowing lagoons, great care should be taken in the selection of flow criteria. Infiltration and inflow in nonexcessive quantities shall be accounted for in the selection of all per capita flow estimates.
- i. The choice of the treatment works on which construction drawings and specifications are to be based should, in most instances, represent the most economically feasible alternative. An economic analysis shall be included in the facilities plan and shall address capital costs, projected operation and maintenance costs, energy costs, salvage values, and projected total annual costs for each alternative under review. Non-monetary considerations should be discussed if they will affect the choice or implementation of treatment alternatives.
 - j. Projects for existing facilities shall thoroughly address the impacts of infiltration/inflow on the collection system. Projects for existing facilities shall include the following information as a minimum:
 1. Description of existing wastewater treatment works.
 2. Flow measurement data - minimum, average, peak (wet weather, dry weather).
 3. Description of any overflow or bypass location(s).
 4. A comparison of flows, effect on the treatment plant and supporting facilities, and proposed treatment of excess flows or flow reduction measures.

Infiltration/inflow information will be required for major treatment plant additions or modifications and lift stations serving large drainage basins.

- k. Waste reduction measures should be discussed in the plan, and should address a minimum of the following:
 - 1. Projects concerning public wastewater treatment systems should address flow and/or strength reduction of wastewaters from industrial or commercial sources where applicable. The use of pre-treatment facilities should be considered along with in-plant process changes, reuse, and reclamation practices.
 - 2. Industrial and commercial facilities should address in-house water conservation and reuse potential in all process and cooling water systems as well as infiltration/inflow in the collection system.
- 1. An identification of effluent discharge limitations for existing treatment works as delineated by applicable National Pollutant Discharge Elimination System permits.
- m. A brief statement demonstrating that the authorities which will be implementing the plan have the necessary legal, financial, institutional, and managerial resources available to insure the construction, operation, and maintenance of the proposed treatment works.
- n. A brief statement delineating the scope and division of authority when a project is a joint effort between private and/or governmental authorities.
- o. A copy of the municipal wastewater ordinance applicable to the project if any.

H. Federal Grant Projects

- 1. Facilities plans subject to Federal grant funding will meet the content and format requirements as specified by appropriate Federal Regulations and Guidelines as published by the U.S. Environmental Protection Agency, as well as the previously listed items in this section.

The design engineer should obtain 40 CFR 35 "Construction Grants for Waste Treatment Works" to serve as a basic document.

- 2. The following Environmental Protection Agency publications are suggested as source material for development of a facilities plan:
 - a. Guidance for Preparing a Facility Plan
 - b. Model Facility Plan for a Small Community

- c. Handbook for Sewer System Evaluation and Rehabilitation
 - d. A Guide to the Selection of Cost-Effective Wastewater Treatment Systems
 - e. Design Criteria for Mechanical, Electric, and Fluid System and Component Reliability
 - f. Evaluation of Land Application Systems
 - g. Pre-treatment of Pollutants Introduced into Publicly Owned Treatment Works
 - h. Operation and Maintenance of Wastewater Treatment Facilities
3. The design engineer should confer with the Environmental Protection Agency for copies of the above publications and any revisions issued since the date of original publication.

I. Professional Engineer's Seal

Facilities plans submitted to the Water Pollution Control Section, Bureau of Water Quality must bear the stamp of a registered professional engineer licensed to practice in the State of Kansas.

II. PRE-DESIGN CONFERENCE

- A. Prior to initiation of final design, it is recommended that the design engineer shall schedule a pre-design conference with appropriate staff of the Water Pollution Control Section, Bureau of Water Quality. The scope of this conference will be determined upon consultation between the design engineer and Water Pollution Control Section, Bureau of Water Quality staff.
- B. For Federal grant projects, the conference should be scheduled at the earliest possible date following necessary State and Federal approvals of the project facilities plan. Non-grant projects may combine discussions on the facilities plan and pre-design topics.
- C. The purpose of the pre-design conference will be to familiarize the design engineer with regulatory review procedures, requirements, as well as applicable State and Federal Statutes pertaining to the project. Discussion of potential problem areas and possible solutions will be included.
- D. The following items are suggested as topics for discussion during the pre-design conference. The design engineer should bring all necessary materials pertinent to these areas of discussion. This material should include any site information, sketches, preliminary drawings and calculations which would aid in resolving problems or questions.
 1. Site Conditions
 - a. Soil conditions and testing
 - b. Groundwater conditions
 - c. Location of site with respect to habitation
 - d. Present conditions at the site
 - e. Procedure for State site inspection
 - f. Existing plant processes, configurations, etc.
 2. Design Parameters
 - a. Hydraulic
 - b. Organic
 - c. Structural
 - d. Electrical
 3. Configuration
 4. Design Policy
 5. Submission and Review of Plans and Specifications
 - a. Number of sets
 - b. Review procedures
 - c. Projected date for submittal

6. Miscellaneous

- a. Emergency power
- b. Alarm or protection systems
- c. Laboratories
- d. Inspection requirements

7. Federal Grant Projects

- a. Step III application
- b. Specification assurances
- c. Projected date for submittal
- d. Extra plan and specification requirements

III. PLAN AND SPECIFICATION PRESENTATION

A Plans

1. Plans for interceptor sewers, outfall sewers, lift stations, new collector systems, sewer extensions, or any combination thereof, shall include:
 - a. A general location map of the municipality, sewer district, subdivision or development served by the proposed project, showing all existing and proposed streets and alleys to the extent possible shall be provided.
 - b. The location and size of all sewer lines, manholes, clean-outs, and other appurtenances shall be indicated. Pertinent elevations shall be indicated on all appurtenances.
 - c. A detailed plan view, including all existing and proposed streets, alleys, lots, utilities lines, adjacent structures and easements, of each reach of the sewer line shall be provided.
 - d. Profiles of all sewer lines with elevations of the sewer inverts at all manholes, and the grade of the sewer line between adjacent manholes shall be provided. Scales of profiles must be clearly stated. The following scale is suggested: vertical - 10 feet to 1 inch; horizontal -100 feet to 1 inch.
 - e. At all outfall structures where stream flow is involved, the approximate elevation of the bottom of the stream shall be shown as well as the approximate elevation of the low water level, the high water level, and other topographic features which might influence alignment or construction.
 - f. High water elevation shall be shown on profiles of sewers subject to flooding.
 - g. If a pump station is proposed as part of the project and overflows from the station could reach well developed areas or recreational impoundments, all residences within 1/2 mile of the proposed pump station that lie in a downstream drainage area and would be affected by a pump station overflow, shall be indicated on a drainage map. Deviations from this requirement will be considered on a case-by-case basis.
2. Plans for any wastewater treatment facility shall include:
 - a. A general layout showing the proposed arrangement of treatment units and areas for future expansion, existing facilities, existing and proposed piping arrangements, embankments, outfall sewer, outfall structure, receiving stream with direction of flow, any tributaries in the immediate

vicinity, and topographic features of the site shall be provided.

- b. Longitudinal and transverse sections for each process unit should be indicated and labeled.
 - c. Details of each unit shall include, but are not limited to inlet and outlet devices, baffles, valves, arrangements of automatic control devices, aeration devices, scrapers, etc.
 - d. Schematic flow diagram(s) and hydraulic profile(s), for wastewater, sludge and supernatant liquor flows shall be provided on the plans.
3. All plans shall include:
- a. Each drawing shall have a legible title showing the subject of the drawing, the name, location and owner of the proposed project, the name and seal of the engineer, scale and date of the drawing.
 - b. Location of underground utility lines paralleling (within 10 feet of either side) or intersecting with sewers shall be shown on both the plan and the profile of sewer and treatment plant plans. This only requires that the location of the underground utility with respect to the sewer line be shown in profile, and does not require profile views of portions of the utility. Public and/or private water wells within 100 feet of sewer lines and 500 feet of treatment plant sites shall be indicated on the plans.
 - c. Information on the ownership, lease and/or easement rights (permanent and temporary) to the property to be used as project sites or routes, shall be shown on the layout (to include both wastewater transportation and treatment plant projects).
 - d. Flood elevations shall be presented where appropriate as follows: New wastewater treatment facilities - 100 year frequency flood; Modifications/additions to existing treatment facilities - 50 year frequency flood; and Lift stations (in areas subject to flooding) - 100 year frequency flood. If this data is not available, information concerning the highest known water level will be provided in the plans.
 - e. The location of all soil test holes, soil boring profiles, rock elevations, and groundwater elevations should be indicated. At the option of the design engineer, this information may be included in the specifications.
 - f. Major design parameters shall be indicated on the plans. This should include but is not limited to flow, BOD₅, total suspended solids, detention times, weir rates, pump rates, pump heads, oxygen transfer, etc. At the option of the

design engineer, this information may be included on a separate plan-sized sheet. This requirement does not apply to sewer extensions.

- g. All structures, appurtenances, section views, plan views, etc. shall be adequately dimensioned.
- h. On Federal grant projects, a minimum of 6 copies of plans and specifications shall be submitted for each project. For non-grant projects, a minimum of 3 sets shall be submitted for each project.

B. Specifications

- 1. Specifications shall accompany all plans for new systems or additions/modifications to existing systems. Where plans are for extensions to sewer systems, the specifications may be omitted, provided it is stated that the work is to be constructed under specifications already on file at the Water Pollution Control Section, Bureau of Water Quality central office. Specifications on file must conform to this document, and be clearly reaffirmed with each submission of plans. The specifications shall be labeled with the name and location of the project as well as the name of the owner and the design engineer.
- 2. The specifications accompanying construction drawings shall include, but are not limited to; all construction information not shown on the drawings which is necessary to inform the contractor in detail of the design requirements as to the quality, workmanship and fabrication of materials, and the type, size, strength, operating characteristics and rating of equipment; allowable infiltration; the complete requirements for all mechanical and electrical equipment, including machinery, valves, piping, and jointing of pipe; electrical apparatus, wiring, and meters; laboratory fixtures and equipment; operating tools; construction materials; special appurtenances; chemicals when used; instructions for testing materials and equipment as necessary to meet design standards; and operating tests for the completed works and component units.

C. Revision to Plans and/or Specifications

Any deviations from approved plans or specifications affecting capacity, flow, effluent quality or operation of units shall be submitted by change order or addendum and approved before such changes are made.

D. Design Calculations and Parameters

- 1. Pertinent design calculations shall be forwarded with the plans and specifications. These calculations should include but are not limited to those for: biological treatment, lift station capacity and head, interceptor sizing, sludge volume(s), water balance for nonoverflowing lagoon, etc.

2. Major design parameters shall be indicated on the plans as indicated previously (see section A.3.f. of this chapter).

E. Plan and Specification - Effective Period

If construction of the proposed project has not taken place within two years following the initial approval of plans and specifications by the Water Pollution Control Section, Bureau of Water Quality, the initial approval shall become void and new plans and specifications shall be re-submitted for review and approval prior to initiating any construction.

F. Record Plans

A complete copy of record plans, specifications, copies of addenda and change orders shall be furnished to the owner in conjunction with the Operation and Maintenance Manual. One copy of record plans shall be furnished to the Water Pollution Control Section, Bureau of Water Quality for microfilm purposes. This requirement does not apply to sewer extensions.

IV. GENERAL DESIGN CONSIDERATIONS FOR SEWAGE TREATMENT WORKS

A. Introduction

Review of plans and specifications by the Water Pollution Control Section, Bureau of Water Quality will be limited to design calculations, functional design and pertinent environmental aspects. Proper functioning of the treatment facility is the responsibility of the design engineer.

B. Degree of Treatment

The Water Pollution Control Section, Bureau of Water Quality will establish the degree of treatment for each waste water discharge. Design engineers should obtain this information prior to preparation of a facilities plan. The degree of treatment shall be equal to secondary treatment as a minimum and shall be consistent with appropriate State and Federal Regulations.

C. Plant Location

1. General

A wastewater treatment plant site should be located as far as practicable from any present developed residential area or any area for which development is proposed within a reasonable future period. The direction of the prevailing winds should be considered when selecting the plant site. If a critical site must be used, special consideration shall be given to the design and type of plant provided. Plants should either be located at an elevation which is not subject to flooding or be adequately protected against flood damage. The plant shall be readily accessible. The site should be of ample size to accommodate expansion and/or the addition of facilities to increase the degree of treatment for a planning period of at least 50 years.

2. Existing Development

All dwellings and business structures within 0.5 miles of a proposed plant location should be shown in the facilities plan and on the final plans.

3. New Developments

All potential house and business locations within 1,000 feet of a new plant location, and the plat of the area to be served by the system should be shown in the facilities plan and on the final plans.

D. Separation Requirements

The following items will apply to the tables presented below:

1. Existing habitations may be served or unserved by the proposed collection and/or treatment system.

2. Proposed development may be served or unserved by the proposed collection and/or treatment system and may consist of new subdivisions, platted land, adjacent platted property, etc.
3. Separation distances may include roadway or railway right-of-ways as long as a minimum of 100 feet from property lines is observed.

Minimum Separation Distances

1. Minimum separation requirements for facilities of 10-99 P.E. are as listed (in feet) in the following table:

<u>Plant Type</u>	<u>Existing Habitations</u>	<u>Proposed Development</u>	<u>Property Lines</u>
Activated Sludge	500*	350	100
Trickling Filter	500*	350	100
Aerobic Lagoon	500*	350	100
Anaerobic Lagoon	1000	1000	100
All other facilities	500*	350	100

2. Minimum separation requirements for facilities of 100 P.E. and larger are as listed (in feet) in the following table:

<u>Plant Type</u>	<u>Existing Habitations</u>	<u>Proposed Development</u>	<u>Property Lines</u>
Activated Sludge	1000*	350	100
Trickling Filter	1000*	350	100
Aerobic Lagoon	500*	350	100
Anaerobic Lagoon	1000	1000	100
All other facilities	1000*	350	100

*This distance may be reduced to a minimum of 350 feet with the written permission of the affected property owner having a habitation less than 1000 feet from the proposed treatment works. The written permission must be a notarized statement from the affected property owner stating that there are no objections to the establishment and construction of the treatment facility. The statement shall not waive any future rights with respect to future action on lack of proper operation and maintenance. A copy of the notarized statement must be furnished to this office, the property owner, and the owner of the treatment plant.

3. The above distances are required minimums. Requests for further reductions or additions must be fully documented and will be reviewed by Water Pollution Control Section, Bureau of Water Quality staff. However, further reductions/additions will not be approved on a routine basis.
4. Where an existing treatment plant has been established on a site with fixed boundaries, modifications, and/or additions to the plant should only be concerned with the 100 foot separation from property lines.

E. Fencing

All sewage treatment plant sites shall be adequately fenced to provide for public safety, to prevent trespassing, preclude livestock entrance, and to minimize the entry of blowing material.

1. Access

A vehicle access gate of sufficient width to accommodate all necessary transportation and mowing equipment shall be provided. The gate shall be equipped with a suitable lock.

2. Height

All plants, except aerated or facultative waste stabilization ponds, having any uncovered structures shall be enclosed with at least a 6 foot, non-climbable fence (minimum 60 inches with two strands of barbed wire to 72 inches).

Aerated or facultative waste stabilization ponds should have at least a 4 foot, hog-tight, woven wire fence (minimum 36 inches with two strands of barbed wire to 48 inches).

3. Warning Signs

Appropriate signs should be provided along the fence around the plant site to designate the nature of the facility and advise against trespassing.

F. Design Considerations

1. Selection of Treatment

Careful consideration should be given to the type of treatment. A few of the important factors which should influence the selection of the type of treatment are: the effect of industrial wastes likely to be encountered; operating costs; the probable type of supervision and operation which the plant will receive, and the required effluent quality.

Special consideration should be given to the feasibility of using wastewater treatment by soil disposal (see the chapter entitled "Land Application of Wastewater Effluent or Sludge"). The feasibility of possible water reuse should also be examined.

2. New Processes, Methods and Equipment

The policy of the Water Pollution Control Section, Bureau of Water Quality is to encourage rather than obstruct the development of new methods or equipment for treatment of wastewater. Consideration will be given to any new method or equipment when adoption of these changes is justified by the designer. Pilot scale test installations can be used as a basis for design of new treatment methods. All pilot scale tests shall be conducted by a competent sanitary engineer other than one employed by the manufacturer or developer. Samples shall be collected and analyzed

to show efficiency under various ranges of influent sewage strength and volume over a sufficient length of time to demonstrate operation under climatic conditions which may be encountered in the area of the proposed installations. Automatic flow measuring and sampling equipment is recommended for performing these tests.

3. Design Period

Wastewater treatment works shall be designed for not less than a 20 year period. Capability to accommodate further expansion shall be provided. Phased construction will only be considered on a case-by-case basis. The phasing of projects shall be consistent with the applicable wastewater plan for the area or region.

4. Industrial Wastes

Where it is technically and economically feasible, the Water Pollution Control Section, Bureau of Water Quality encourages the utilization of municipal wastewater treatment facilities to collect and treat industrial wastewaters. Where appreciable amounts of industrial wastes are involved, consideration shall be given to the character and technical feasibility of treating such wastes in the design of the plant.

5. Organic and Total Suspended Solids Loading

A population equivalent (P.E.) is defined as 0.17 pounds of BOD₅/capita/day and/or 0.21 pounds of TSS/capita/day. If monitoring and other laboratory data are inadequate for the development of per capita contributions, it is recommended that these values be utilized. The above does not require the design engineer to use these particular per capita contributions for design.

6. Hydraulic Loading

The design of treatment units is usually based on the average rate of sewage flow per 24 hours. However, the flow from most commercial and industrial developments usually varies in magnitude much more than those observed for a municipality. Therefore, the design flow rate for commercial and industrial contributors should be based on actual flow measurement or on flow data furnished by the industry.

- a. Peak flows which adversely affect the detention time of treatment units or the flow characteristics of conduits shall be determined.
- b. Hydraulic data obtained from existing similar installations can be used for designing new systems; however, caution must be exercised when using this approach.
- c. A hydraulic profile of the wastewater treatment plant must be developed and submitted with the design and is to include

the outfall line and receiving stream high water elevations (see chapter entitled "Plan and Specification Presentation").

7. Operation and Maintenance Manual

A complete operation and maintenance manual shall be provided by the design engineer and submitted to the Water Pollution Control Section, Bureau of Water Quality for each wastewater treatment facility with a design capacity greater than 10 P.E., prior to the beginning of the operation of the facility. The manual shall be written in a manner easily understandable to the treatment plant operator and should have two distinct sections: operational section and maintenance section. The manual should cover the National Pollutant Discharge Elimination System Permit or applicable State of Kansas Permit outstanding for the facility and all reporting requirements contained therein. The manual should cover all details of the operation and maintenance of the wastewater treatment facility and include valve or gate settings, pipe diagrams, lubrication schedules, safety procedures, emergency operation procedures, sludge disposal and other items of concern.

8. Operating Equipment

The design engineer should review existing equipment and facilities utilized for maintenance. Equipment or additions necessary to provide adequate maintenance should be delineated in the specifications. Specific attention should be given to specialized tools or equipment necessary for equipment repair. A tool list is required and should include items such as squeegees, wrenches, valve keys, rakes, shovels, portable ventilation equipment, and common hand tools.

G. Plant Details

1. Conduits

All piping and channels should be designed to carry the maximum expected flow. The incoming sewer should be designed to provide a free water surface at the maximum expected discharge. In the event a solids deposition problem in the channel is expected, the bottom corners of rectangular channels should be filleted to eliminate pockets and corners where solids can accumulate. Suitable sluice gates or slide gates should be placed in channels to seal off unused sections which might accumulate solids. The use of shear gates or stop planks in lieu of slide gates or sluice gates is permitted where it can be shown they will give satisfactory service.

2. Arrangement and Reliability of Units

Component parts of the plant should be arranged to provide for the greatest possible operating convenience, flexibility, and economy. Plant layout should be designed to facilitate installation of future units. When possible, at least two treatment units of each type should be provided. The design should provide

for undertaking maintenance or repair activity with a minimum loss in treatment efficiency. For treatment facilities designed for 10,000 P.E. or greater, it is recommended that duplicate units be provided.

3. Installation of Mechanical Equipment

The specifications should require initial inspection and operation of all major items of mechanical equipment by a representative of the manufacturer after installation. The representative of the manufacturer shall prepare and submit to the Water Pollution Control Section, Bureau of Water Quality a signed statement indicating that acceptable installation and operating trials have been conducted. This statement shall contain the dates of the trials and the signature of the persons making and witnessing the trials.

4. Controlled Diversion and Dewatering Headworks

Bypasses shall be provided so each unit of the plant can be independently removed from service. Provision is to be made so that untreated raw sewage shall not be bypassed into the receiving stream.

5. Construction Materials and Paints

Materials used in sewage treatment works should be resistant to deterioration from hydrogen sulfide and other corrosive gases, greases, oils, and similar constituents frequently present in sewage. This is particularly important in the selection of metals and paints. Contact between dissimilar metals should be avoided to minimize galvanic action.

Lead paints shall not be used. In order to facilitate identification of piping, particularly in large plants, it is suggested that different lines have contrasting colors. The following color standards are recommended.

Raw Sludge Line	Black
Sludge Recirculation Suction Line	Yellow
Sludge Drawoff Line	Orange
Sludge Recirculation Discharge	Brown
Sludge Gas Line	Red
Natural Gas Line	Red W/Black Bands
Potable Water Line	Light Blue
Water Heating Lines	Blue W/Red Bands
Nonpotable Cleanup Water	Blue W/Black Bands
Sewage Line	Gray
Compressed Air Line	Green
Chlorine Line	Yellow W/Green Bands

6. Grading and Landscaping

Upon completion of plant construction, the ground shall be graded, seeded and/or sodded. Concrete, asphalt, or gravel walkways

should be provided for access to all units. Walkways are not required for waste stabilization ponds.

Where possible, steep slopes should be avoided. Surface water shall not be permitted to drain into any unit. It is recommended that the slope of earth fills around structures be no steeper than 3.5 horizontal to 1 vertical. Provisions should be made for landscaping, particularly when a plant is located close to residential areas. Where grass cover is necessary, accessibility to water via yard hydrants is desirable.

7. Water Supply and Sanitary Facilities

An adequate supply of water under pressure should be provided at several locations in a plant except for waste stabilization ponds. No piping or other connections shall exist in any part of the treatment works which, under any conditions, might cause the contamination of a potable water supply.

Hand washing facilities should be provided in all treatment works with the possible exclusion of waste stabilization ponds. Where operating personnel are located at the site for an eight hour period or more, a shower, water closet and drinking fountain should also be provided.

8. Laboratory Space and Equipment

All treatment works, except non-overflowing waste stabilization ponds and facilities serving a population equivalent of ten or less, shall include a laboratory equipped for making analytical determinations and operating control tests, unless testing is to be conducted at another facility or commercial laboratory. The type of testing program required varies with the type and size of the plant. Recommended testing programs are contained in the chapter entitled "Laboratory Requirements".

H. Flow Measurement

1. General

Flow measurement capability shall be provided for all wastewater treatment plants. The type and extent of measurement capability shall depend upon the hydraulic capacity and type of treatment processes involved. The following criteria shall apply for flow measurement installations. (See table on following page)

2. Location of Flow Measurement

Influent flow measurement shall be installed following preliminary treatment processes such as screening, grit removal, etc., and prior to the initial major treatment processes (sedimentation, trickling filter, activated sludge, pond, etc.). Flow measurement equipment should not be placed where it will be subject to a severe cyclic variation of flow due to the operation of pumps immediately upstream. If this is not possible, steps should be taken to reduce this effect as much as possible.

Effluent flow measurement shall be installed following the last major treatment process (final clarification, filtration, etc.) and may precede any effluent disinfection facilities.

Influent and effluent flow measurement shall not include recirculation flows unless recirculated flows are measured separately.

MINIMUM FLOW MEASUREMENT CRITERIA FOR NEW PLANTS

<u>Type & Size of Treatment System</u>	<u>Location of Flow Measurement</u>	<u>Type of Flow Measurement</u>
1. All mechanical treatment plants of 0.05 MGD capacity or greater (average design flow).	Influent or Effluent	Continuous Indicator-Recorder
2. All mechanical treatment plants of less than 0.05 MGD capacity (average design flow).*	Influent or Effluent	Weir Installation
3. Discharging Lagoon Systems	Influent and Effluent	Weir Installation
4. Non-overflowing lagoon system**	Influent	Weir Installation

*If the system receives influent flow directly from a pump station, influent flow measurement by pressure flow must be provided.

**If the system receives flow directly from a pump station, consideration will be given to the use of recording time meters in conjunction with pump discharge rates for influent flow measurement. (for systems of less than 0.10 MGD capacity at average design flow.)

Flow measurement capability should be provided for large capacity pump stations regardless of location in the wastewater collection system.

Alternate locations for wastewater flow measurement shall be considered if an existing plant is being modified.

Calibration, maintenance, and trouble shooting information for each component of a flow measurement system shall be fully delineated in an Operation and Maintenance Manual prepared for the wastewater treatment system.

3. Continuous Flow Measurement

Continuous flow measurement devices shall be capable of indicating, through a direct readout or gauge dial, the instantaneous wastewater flow rate. The measurement system shall be able to indicate the maximum design flow of the wastewater treatment system. The continuous flow measurement system shall also provide

for the recording of flow for a minimum period of 24 consecutive hours. The totalized flow should be indicated on the recording.

The following configurations are acceptable continuous flow measurement systems when utilized in conjunction with float, pressure sensors, or any other acceptable means of translation:

1. Parshall Flume
2. Cipolletti Weir
3. Rectangular Sharp-Crested Weir
4. V-Notch Sharp-Crested Weir
5. Venturi Tubes or Flow Tubes
6. Magnetic Meters
7. Ultrasonic Devices

4. Instantaneous Flow Measurement

Rectangular, V-Notch or Cipolletti sharp-crested weirs are acceptable configurations for instantaneous flow measurement facilities. The following points should be carefully considered in the design and installation of this type of facility.

- a. Approach channel dimensions shall be provided such that appropriate hydraulic head and velocity considerations are taken into account.
- b. The weir should be of a type, size, and shape to properly handle the expected range of wastewater flow through the plant or an individual plant component.
- c. All dimensions and geometry of the weir plate should be appropriate with respect to the theoretical requirements for a chosen weir type.
- d. Vertical alignment of weir plates must be emphasized in installation and operation.
- e. Staff or hook gauges shall be provided such that plant operators may determine hydraulic head on the weir.

5. Recirculation Flow

Separate measurement shall be provided for recirculation flows in all plants utilizing recirculation. Deviations will be allowed on a case by case basis.

I. Sludge Handling and Disposal

1. Sludge Handling Methodologies

All treatment plants, except ponds, must have a sludge handling system with suitable backup equipment to provide at least one alternative sludge handling procedure. Care should be taken so the methods utilized are capable of functioning year-around including extended periods of inclement weather. Procedures utilized may

include sand drying beds, mechanical dewatering facilities, liquid sludge handling facilities, and incineration.

2. Ultimate Sludge Disposal

The design engineer should address himself to a complete sludge disposal system to include sludge transportation to off-site disposal areas, routine of sludge transport, long term contractual arrangements for land application or sanitary landfill disposal, and the ultimate use of land and subsequent crops in the case of agricultural application. The operation and maintenance manual must give adequate detail to sludge disposal under all climatic conditions. All wastewater sludges shall be adequately stabilized prior to ultimate disposal. Design features of the sanitary landfill or agricultural application site must be incorporated in the project plans and specifications. Sludge incineration equipment must meet applicable air pollution requirements. (See the chapter entitled "Land Application of Wastewater Effluent or Sludge").

J. Safety Features

1. Ventilation

Forced air ventilation shall be provided for all below ground level structures which require regular maintenance or inspection, and that may be subject to the accumulation of toxic and/or combustible gases. Ventilation, if continuous, shall provide at least six complete air changes per hour; if intermittent, at least 30 complete air changes per hour. Alternative ventilation systems in larger facilities may be utilized. Manholes and those units specifically delineated in the chapter entitled "Sewage Pumping Stations" are exempted. The ventilation equipment, if not continuously operated, shall be activated whenever the lights are energized. Atmospheric vents shall be provided, when forced air ventilation systems are not required, to avoid accumulation of toxic and/or combustible gases.

2. Electrical Fixtures

Electrical fixtures in enclosed places where gas may accumulate shall comply with the National Board of Fire Underwriters specifications for hazardous conditions.

3. Gas Burning Equipment

Gas burning equipment shall be placed in a separate room so that adequate ventilation can be provided for the burners and so that ventilation facilities for the building will not interfere with the operation of the burners.

4. Handrails and Guards

Handrails and/or guards shall be provided where necessary.

5. Protective Clothing and Equipment

Gas masks, goggles, gloves, first aid kits, fire extinguishers, and other protective clothing and equipment shall be provided where needed.

6. Signs

"No Smoking" and other warning signs should be posted in hazardous areas. Special valve and switch operation signs should be placed so as to be in the immediate line of sight of operating personnel.

K. Emergency Operation

1. Flooding (New Treatment Plant Construction)

- a. All units shall remain fully operational during the 25 year flood frequency event.
- b. All units required to provide primary treatment (pumping, screening, and removal of settleable solids) shall remain fully operational during the 50 year flood frequency event.
- c. All structures, electrical, and mechanical equipment shall be protected from damage due to the 100 year flood frequency event.
- d. Construction within the 100 year flood plain shall only be considered if the restrictive effects of the proposed construction are analyzed and presented within the scope of the facilities plan.
- e. Floodproofing of all new facilities should be considered.

2. Flooding (New Pump Station Construction)

- a. All units shall be above the expected 100 year flood frequency event for the proposed site. Where this data is unavailable, records of the highest historical flood level, or the engineer's best estimate, may be utilized.
- b. Floodproofing should be considered for all possible points of access to station wet wells and dry wells.

3. Flooding (All Existing Facilities)

- a. Additions or modifications should consider floodproofing and where practicable, should conform to the flood protection levels specified above.

4. Standby Power (New Construction)

- a. Sufficient standby power either from a second line source or from portable or on-site generating equipment shall be provided to allow for a minimum of primary treatment at all times.

- b. Modifications or additions to existing facilities should provide for standby power capability.

V. SOILS

A. Introduction

The standards delineated in this chapter pertain only to the soils related design of earthen basins for the retention of wastewater and appurtenant structures. No effort has been made to develop standards for the soils related engineering design of mechanical treatment units, buildings, and similar structures.

B. Compaction Requirements

1. Definitions

All soil compaction specified on water pollution control projects shall be referenced to maximum standard proctor density (AASHTO T-99; ASTM D-698). Specified minimum compaction requirements shall vary depending on the ultimate use of the soil. For this reason, the following definitions are offered:

Earthen Structure: Any basin, excavation, and/or embankment in which wastewater is in direct contact with the soil, i.e., aerobic ponds, anaerobic ponds, polishing ponds, overflow ponds, sludge storage ponds.

Foundation: Any soil directly supporting a man-made structure. Man-made structures include anything constructed of conventional building materials.

2. Compaction

The minimum compaction requirements shall be as outlined below:

a. Earthen Structures

Compaction of the embankments and upper 12 inches of the interior bottoms of earthen structures shall be a minimum of 95% of the maximum standard proctor density. The maximum thickness of uncompacted layers of uncompacted material to be compacted shall be 6 inches. The moisture content range shall be optimum moisture to optimum moisture plus 3%.

b. Foundations

Minimum compaction requirements for soils acting as foundations shall be 100% maximum standard proctor density to a depth of 12 inches below the structure. Moisture content range of the soil shall be optimum moisture to optimum moisture plus three percent.

C. Soils Analysis for Earthen Structures

The water loss through embankments and bottoms of any earthen structure which is an integral part of the wastewater treatment system shall be based on soil permeability test results. The procedure for the analysis of permeability is outlined below:

1. Sampling

A subsurface investigation of the earthen structure construction area shall be performed as part of the facilities plan. The material sampled for analysis shall be representative of the type of soils which will be located in the top 12 inches of the earthen interior basin. This may be accomplished by either sampling at the design elevation of the bottom of the earthen basin or by selective excavation and backfill. Sufficient test holes shall be made to ascertain the major variations in the soil strata which may be present in the area to be used for the pond bottom and embankments. Verification of any groundwater within 10 feet of the lagoon bottom and of any rock that will require excavation should be made at this time. A sufficient number of samples should be obtained to adequately determine the permeability characteristics of soil in the area of design elevation of the pond bottoms and embankments. (A minimum of three samples per site are required).

2. Testing for Coefficient of Permeability

Tests shall be performed in accordance with the procedure set forth by ASTM D-2434. The samples subjected to the test shall be compacted to a minimum of 95% of the maximum standard proctor density at a moisture content range of optimum moisture to optimum moisture plus 3% and tested at a head equal to the maximum operating depth of the pond. Each sample shall be replicated 3 times, and widely varying test results retested. The coefficient of permeability shall be based on the average of the three usable test results.

3. Determination of Water Loss Through Soil

Using the coefficient of permeability, the rate of loss of wastewater through the soil may be found. Darcy's equation may be revised to yield this value:

$$\text{Loss} = Q/At = \frac{kh}{L}$$

Where, k = coefficient of permeability feet/day.

h = maximum depth of pond, feet.

L = width of compacted soil layer in pond bottom, feet.

It is this water loss value that must not exceed 1/4 inch per day for aerobic, aerated, non-overflowing, overflow, and sludge storage ponds, and must not exceed 1/8 inch per day for anaerobic ponds. In addition, the loss value derived from this equation is used in the water balance calculations for non-overflowing pond designs. Because the loss value is necessarily dependent on the depth of water and width of compacted soil, the derivation of the value must be related to the maximum allowable operational depth permitted for the chosen type of pond system and to the construction specifications for the project.

4. Test Results

(1) For non-overflowing ponds, if the calculated average water loss through the pond embankments and bottoms is less than a rate of $1/4$ inch per day, the value obtained from testing shall be used in the design (hydraulic balance calculations) of the earthen structure. If the test yields a calculated average water loss through the pond embankments and bottoms greater than $1/4$ inch per day, the soil will require the addition of a soil sealant or impermeable membranes. The amount of the soil sealant must be sufficient to reduce the calculated water loss through the pond embankments and bottoms to $1/4$ inch per day or less. The sealant application rate must be based on the tests outlined under section C.2 of this chapter. The sealant used in the laboratory testing must be representative of that to be used in the actual construction of the earthen structure. The resultant calculated water loss through the pond embankments and bottoms of the sealant-soil mixture shall be used in the design (hydraulic balance calculations) of the non-overflowing pond system.

(2) For discharging ponds, if the average calculated water loss through the pond embankments and bottoms is less than $1/4$ inch per day, no sealant will be required. If the test yields an average calculated water loss through the pond embankments and bottoms greater than $1/4$ inch per day, the soil will require the addition of a soil sealant or impermeable membranes as discussed in (1) above. In-place tests in conformance with the Earth Manual of Bureau of Reclamation during construction in lieu of laboratory testing may be utilized for discharging ponds only.

5. Testing of Wastewater Treatment Ponds

After soil sterilization is completed, the first pond to be put into use shall be filled to the minimum operational level using a suitable water source. The transfer gate valves and/or stop planks of the outlet structures shall be closed and sealed before filling. Beginning not less than 7 days after filling is completed, the tests shall be performed to determine the water loss through the bottom and the embankments of the pond. The calculations for the water loss value must consider the influences of precipitation and evaporation during the test period.

If the water loss through the pond embankments and bottoms exceeds $1/4$ inch per day, the ponds shall be drained and reworked in accordance with the requirements of this chapter and tested again. This procedure shall be repeated until the water loss through the pond embankments and bottoms is $1/4$ inch per day or less. Because water loss through the soil is proportional to the depth of water, this must be considered in computing the water loss where the minimum operating level varies from the one specified in the original derivation of the water loss figure.

The results of all on site testing and the appropriate water balance calculations shall be submitted to the Water Pollution Control Section, Bureau of Water Quality upon completion of the tests.

6. Impermeable Membranes

Membranes shall have a minimum thickness of 30 mils (0.50 mm) and as a minimum shall conform to the requirements set forth by ASTM D-3083.

7. Soil Sealants

Soil sealants shall be either artificial or naturally occurring bentonite clays. The primary constituent of the clays shall be sodium montmorillonite. The use of pyrophosphates, and variations of pyrophosphates, as a soil sealant for earthen structures, will not be accepted.

D. Presentation of Data

When ponds are the chosen method of treatment, the soils information required below must be submitted prior to the design of the ponds. For non-overflowing pond systems, the permeability information required in Section C. and the best available groundwater elevation information shall be determined and submitted in the facilities plan.

1. The profiles of the borings shall be clearly drawn on adequately sized paper. Information relating to boring elevations and depths, soil types, permeability test results, depth of soil horizons, water table elevations and possible selective excavation shall also be presented in the profiles. Should a soil sealant be required, the rate of application in pounds per square foot, methods of mixing and compaction, and the attendant coefficient of permeability value shall also be presented.
2. A laboratory test report with the permeability test results and calculated water loss through the pond embankments and bottoms shall be submitted. The laboratory test report shall include but not necessarily be limited to the following:
 - a. Present Site Conditions
 1. Vegetative cover.
 2. Presence of existing streams, water courses, and water-ponding.
 3. General topography, showing the location of the proposed facility and the borings.
 4. Man-made features such as structures and roads.
 - b. Geological Features
 1. The existence of possible underground workings such as mines and areas subject to subsidence due to oil or water withdrawal.
 2. Presence of possible earth movements due to faulting or folding of the rock stratum.
 3. Presence of cavernous limestone and other porous stratum subject to surface collapse.

- c. Subsurface Soil and Rock Conditions
 - 1. A drawing showing the extent and nature of the horizontal variations in the strata.
 - 2. Logs indicating the possible horizontal variation in the sub-surface soil and/or rock strata.
 - 3. The location of groundwater if encountered.
 - 4. The propensity of the drill holes to cave and any other information that may be pertinent to the analysis, design, and construction of the facility.
 - 5. Samples secured, including sampling locations in each of the borings, sample number, type of sample taken, field description, and deposition of the sample.
- d. Testing
 - 1. Summary sheet showing the results of all test procedures.
 - 2. Data sheets showing the raw test results.
 - 3. Any variations from prescribed procedures.
 - 4. Evaluation of the validity of the data.
 - 5. Analysis of permeability, including amount of bentonite to be used per square foot, if required.
- e. Recommendations

VI. SANITARY SEWER DESIGN

A. Type of Sewers

Separate sewers will be required for the collection of wastewater and stormwater. Roof, areaway, garage, or foundation drains shall not be connected to sanitary sewers as prohibited by Regulation 28-16-55 of the Water Pollution Control Section, Bureau of Water Quality.

B. Design Period

Wastewater collection systems containing lines up to and including a diameter of 18 inches should be designed for the estimated ultimate population of the area served. Sewers with a diameter larger than 18 inches should not be designed for less than a 25 year period unless staged development has been proposed in an approved facilities plan for the project.

C. Design Basis

1. Per Capita Flow

The sewerage system should be designed with the best available information under all circumstances. The information should be obtained from direct wastewater flow measurements via a reliable device. Where information from direct measurement is not available, as in new systems, secondary flow estimation methods such as water use information in winter months may be substituted. Infiltration and inflow in nonexcessive quantities shall be accounted for in the selection of per capita flow estimates.

2. Design Flows

The design flow for sanitary sewers should be selected after consideration is given to the nature of the contributing area. Higher maximum to average flow rates should be used for smaller areas. Suggested ranges vary from 2.0 to 5.0 times the average flow for derivation of maximum design flow.

3. Design Flow Depth

Sewers up to and including a diameter of 18 inches should carry the design flow when running two-thirds full. Sewers larger than 18 inches in diameter should carry the design flow when running three-fourths full.

4. Capacity

- a. In areas which are substantially developed, the design capacity is to be based on existing measured flows, an allowance for non-excessive infiltration/inflow, and capacity for reasonable future development.
- b. Sewers larger than 24 inches in diameter must be economical when compared to small size sewers in the initial installation with later parallel sewers.

- c. The following table is provided as a guide for minimum acceptable design flows in sewer sizing for undeveloped areas. Design flows less than the figures given in the table must be thoroughly justified with appropriate documentation. Note that the flows contain an allowance for non-excessive infiltration/inflow. For Federal Grant projects, the table indicates the design flows for pipe sizing that will receive the full level of Federal participation. Larger pipe sizes derived from larger design flows will be funded only to the eligible pipe size derived from the design flows shown in the table.

Note: See table on following page.

D. Details of Design, Construction, and Materials

1. Minimum Size

No public gravity sewer shall be less than 8 inches in diameter.

2. Depth

A minimum earth cover of 30 inches shall be provided for all sewers of material other than cast iron. Where this depth of cover is not available, protection shall be provided by earth fill, encasement in concrete, or construction with cast iron.

3. Slope

The vertical gradient shall be such that a velocity of at least 2.0 feet per second for pipes flowing one-half full will be maintained, based on Manning's formula using $n = .013$.

For eight inch pipe only, the following requirements apply:

- a. The minimum acceptable grade for the pipe will be 0.4%, regardless of material of construction, except as noted below.
- b. Grades down to 0.3% for any type of pipe will only be accepted when a lift station may be eliminated, where the cost of constructing the sewer line at 0.4% grades will be extremely prohibitive as compared to the cost of constructing the line at 0.3% plus the cost of the additional maintenance the line will require, or where other technical considerations warrant the use of grades down to 0.3%. The use of grades below 0.4% will not be routinely authorized.
- c. Where grades below 0.4% are utilized, the Water Pollution Control Section, Bureau of Water Quality will require notification from the owner of the system in question that potential exists for additional maintenance, and that they are prepared to take necessary action to prevent deposition of solids.

MINIMUM BASIS OF DESIGN

Pipe Size and Flow	TYPE OF DEVELOPMENT			
	Single Family	Multi-Family (Medium Density)	Multi-Family (High Density)	Commercial Industrial
*Design Q 8" - 18"	0.0046 cfs/acre	0.0084	0.0139	0.0077 0.0155
**Actual Q	0.0058 cfs/acre	0.0106	0.0176	0.0097 0.0196
**Design Q Larger than 18"	0.0046	0.0084	0.0139	0.0077 0.0155
***Actual Q	0.0051	0.0092	0.0153	0.0085 0.0170

*Pipe to carry design flow at 0.67 depth of flow (see Item 2 below)
 **Pipe to carry design flow at 0.75 depth of flow (see Item 3 below)
 ***Actual Q = Full Pipe Flow

1. Assumptions include 100 gpcd, peak flow is 3 x Average Dry Weather Flow, minimum grades.

Single Family - 3-3.5 units/acre, 3 people/unit, 10 people/acre

Multi-Family (Medium Density) - 4-5 units/acre, 3 people/unit, 18 people/acre

Multi-Family (High Density) - 6-12 units/acre, 2.5 people/unit, 30 people/acre

Commercial - 5000 gpd/acre

Industrial - 10,000 gpd/acre

2. Pipe size 8" - 18" to carry design flow at 0.67 depth of flow.

3. Pipe size larger than 18" to carry design flow at 0.75 depth of flow.

4. Example Calculation - Single Family, 8" - 18" sewers, pipe to carry design flow at 0.67 depth of flow, Design Q = 0.79 Actual Q (Full Pipe Flow).

$$Q \text{ Design} = \frac{100 \text{ gpcd} \times 10 \times 3.0 \times 1.547}{1,000,000} = 0.00464 \text{ cfs/acre}$$

$$Q \text{ Actual} = \frac{0.0046}{0.79} = 0.0058 \text{ cfs/acre}$$

SLOPES REQUIRED FOR $V = 2$ fps
FOR FULL AND HALF FULL FLOW
Slope in %

Pipe Diameter (inches)	$n = 0.013$
10	0.248
12	0.194
15	0.145
18	0.114
21	0.092
24	0.077
27	0.065
30	0.057
33	0.051
36	0.045

- d. When two sewers of the same size and same slope are joined by a manhole, a continuous grade through the manhole may be provided.

4. Increasing Size

When a sewer joins a larger one, the invert of the larger sewer should be lowered sufficiently to maintain a continuous energy gradient. Approximate methods for securing this result are to place the 0.8 depth point of both sewers at the same elevation or to place the crowns of the sewers at the same elevation.

5. High Velocity Protection

- a. Where flow is continuous and grit is a problem, and where velocities greater than 10 feet per second in the sewer are possible, special provision shall be made to protect against erosion. This protection may be secured utilizing cast iron, ductile iron or steel pipe.
- b. Where pipe slopes exceed 15% and manhole spacings exceed 100 feet, special provisions must be made to anchor the sewer securely at least for every 100 foot of sewer. The use of concrete collars and/or concrete encasement is recommended for this purpose.

6. Sewer Joints

Sewer joints shall be designed to minimize infiltration-exfiltration and to prevent the entrance of roots. Premixed cold joint material or cement mortar joints shall not be used. This prohibition does not prevent use of factory-applied joints of demonstrated quality.

7. Inverted Siphons

Inverted siphons should have not less than two barrels with a minimum pipe size of 6 inches and shall be provided with necessary appurtenances for convenient flushing and maintenance. For easy hydraulic removal of solids, the following maximum grades are recommended on the rising leg: 6-inch pipe - $11\frac{1}{2}^{\circ}$, 8 to 12-inch pipe - $22\frac{1}{2}^{\circ}$, greater than 12-inch pipe - 45° . The manholes shall have adequate clearances for rodding and in general sufficient head shall be provided and pipe sizes selected to maintain velocities of at least 3.0 feet per second for average flows. The inlet and outlet head losses should be addressed. The details shall be arranged so that the average flow is diverted to 1 barrel and so that either barrel may be taken out of service for cleaning.

8. Materials for Sewers

Sanitary sewer pipe shall be constructed of material resistant to or protected from bacterial degradation, acid and alkaline solutions, normal sewer temperature variation, abrasion, and industrial wastes or other materials which may be transmitted by the collection system.

Types of commercial pipe frequently approved for gravity sanitary systems include*:

a. Vitrified Clay Pipe

Extra strength and standard strength clay pipe ASTM C700.

b. Reinforced Concrete Sewer Pipe

Where conditions are especially conducive to the production of hydrogen sulfide gas, appropriate steps shall be taken to provide protection for the pipe. ASTM C76.

c. Ductile Iron Sewer Pipe

USASI A 21.50 (or AWWA H3), USASI A 21.51 (or AWWA C151), and A 21.52.

d. Cast Iron Pipe

ASTM A 377

e. ABS Composite Sewer Pipe

ASTM D 2680

f. ABS Solid Wall Pipe

ASTM D 2751

*Referenced standards apply to the latest revision of the standard.

- g. PSM Poly (Vinyl Chloride) PVC Sewer Pipe & Fittings
ASTM D 3034
- h. PSP Poly (Vinyl Chloride) PVC Sewer Pipe & Fittings
ASTM D 3033
- i. Asbestos - Cement Non-Pressure Sewer Pipe
ASTM C 428

Other materials such as fiberglass, polyethylene, etc., may be approved on a case-by-case basis until further experience is gained with these products. It is essential that manufacturing representatives make themselves available to the consultant and the Water Pollution Control Section, Bureau of Water Quality during all phases of design and construction.

9. Bedding

Trench bottoms should be kept dry and stable during trench preparation and until the pipe line installation is completed to the extent that no damage from hydrostatic pressure, floatation, or other causes will result. Pipe bedding shall be required for all types of pipe and under all conditions except cast and ductile iron pipe.

- a. Rigid sewer pipe (VCP, reinforced concrete pipe, asbestos-cement pipe, cast and ductile iron pipe) is defined for the purposes of classification in this document as sewer pipe that will crush or fail structurally before it will deflect an appreciable amount.
 - 1. Pipe bedding for VCP shall conform with the current ASTM Standard Recommended Practice C-12, Class C or WPCF Manual of Practice No. 9 (ASCE - Manuals and Reports on Engineering Practice - No. 37), Class C improved bedding as a minimum.
 - 2. Other types of rigid pipe shall be bedded in conformance with their respective ASTM pipe specification. (See section D.8. of this chapter entitled "Materials for Sewers").
- b. Semi-rigid sewer pipe (ABS Composite Pipe) and flexible sewer pipe (PVC Pipe and ABS Solid Wall Pipe) are defined for the purposes of classification in this document as pipes which will deflect appreciably before they will crush or fail structurally. Pipe bedding for semi-rigid and flexible pipe shall conform to current ASTM specification D 2321.

10. Trenching

Wherever possible, trench widths shall not be more than 24 inches greater than the pipe diameter for pipes 30 inches in diameter or

less. Wider trench widths may be used for larger than 30 inch pipes and/or trenches greater than 14 feet deep.

11. Sewer Service Connections

Vertical risers for sewer service connections shall not be utilized. The following are two methods of installing riser pipes that are approved by the Water Pollution Control Section, Bureau of Water Quality.

- a. Where conditions permit, the branch connection shall be set at no greater than 45° to the horizontal and the riser brought to the appropriate location utilizing no greater slope than that given by the branch connection angle.
- b. In situations where the sewer trench is of minimum width and the trench walls are of vertical, firm, undisturbed materials, the branch connection shall be set at 45° to the horizontal and a 45° bend shall be placed on the branch. The branch and bend shall be encased in concrete. The riser pipe shall be set into the 45° bend and extended up the trench wall to the appropriate depth. The wall of the ditch shall be recessed to contain at least one-half of the vertical riser pipe. Each pipe joint shall be securely pinned in place by driving two stakes into the solid bank at such an angle as to prevent movement of the pipe when backfilling.

12. Aerial Crossings

- Support shall be provided at all joints in pipes utilized for aerial crossings. Cast iron or ductile iron pipe must be utilized for aerial crossings. Steel pipe is acceptable for encasement pipe.

13. Highway and Railroad Crossings

Adequate protection shall be provided to prevent failure of the sewer line or force main at highway and railroad crossings. The design engineer must demonstrate the adequacy of the protection provided.

14. Pressure Sewer Collection Systems

Pressure sewer collection systems may be utilized where adequate justification is given for their use. The entity that will have responsibility for maintaining the system must demonstrate that it has the capability and manpower to operate and maintain the system. When sufficient design information is felt to be available, further criteria will be provided in this document. Project submittals considering the use of this type of system shall submit the latest design information available.

E. Acceptance Tests for Sewers

1. Alignment

- a. Sewers should be laid with straight alignment between manholes. Alignment tests such as "lamping" or TV inspection must be conducted. The use of advanced construction techniques such as a laser assistance is recommended.
- b. Sewers may be laid with curved alignment provided a manhole is constructed at each end of the curve and a constant degree of curvature is provided. The use of curved sewers will be approved by the Water Pollution Control Section, Bureau of Water Quality on a case-by-case basis only. The engineer will be required to conduct adequate tests of the curved sections of sewers. The owners of the system with curved sewers shall demonstrate that they have the capability to clean and maintain the curved sewers.

2. Infiltration-Exfiltration

Hydrostatic or air pressure tests shall be conducted on sewers before acceptance by the owner. For sewers with a diameter less than 24 inches, the infiltration-exfiltration shall not exceed 250 gallons per day per inch of nominal pipe diameter per mile of sewer line for any section of the system. For sewers with a diameter 24 inches or greater, infiltration-exfiltration shall not exceed 6000 gallons per day per mile of pipe.

- a. For hydrostatic tests where sewers are laid above the groundwater table, exfiltration tests shall be conducted. Where sewers are laid within the groundwater table, infiltration testing shall be conducted. Exfiltration tests must be conducted with a minimum of four feet of static water head above the invert of the sewer at the upstream manhole. Manholes shall be tested using internal or internal hydrostatic pressure. A minimum hydrostatic head of 4 feet is required for the test. Infiltration-exfiltration shall be less than 1.14 gallons per day per vertical foot of manhole (equals 6,000 gallons per day per vertical mile).
- b. Low pressure air testing may be conducted on any type of 8 inch to 12 inch diameter pipe. Testing methods and air leakage rates shall conform to ASTM C828-76T or the latest revision thereof as a minimum. Manholes, which cannot be properly air tested, shall be visually inspected and leakage tested using internal or external hydrostatic pressure. A minimum hydrostatic head of 4 feet is required for the test. Infiltration-exfiltration shall be less than 1.14 gallons per day per vertical foot of manhole (equals 6000 gallons per day per vertical mile).

3. Deflection Testing (refer to Section D.9. of this chapter for definitions).

After flexible and semi-rigid pipe has been laid and backfilled, the engineer shall require a deflection test. The maximum allowable deflection shall not exceed 5.0% of the pipe's internal diameter. The deflection test shall consist of guiding a device of the appropriate size through the pipe to accurately measure any deflection in the pipe. Attention should be given to the fact that the pipe's nominal diameter is greater than the actual internal diameter of the pipe. Lamping will not be approved for deflection testing.

F. Manholes

Manholes shall be constructed of materials resistant to or protected from bacterial degradation, acid and alkaline solutions, normal sewer temperature variation, abrasion, industrial wastes or other materials which may be transported by the sewer.

1. Location

Manholes should be provided at the end of each line; at every change in grade or alignment; at all intersections; where pipe sizes change; and at distances not greater than 400 feet for sewers 18 inches or less in diameter and approximately 600 feet for larger sewers. Exceptions to these requirements may be made where the owner operates and maintains equipment capable of cleaning longer sections of sewers.

An exception to this policy is the permitted use of 45° cleanouts to terminate lines in non-traffic areas not greater than 150 feet from the nearest downstream manhole.

2. Access

The primary purpose in constructing manholes is to provide access to the sanitary sewer for inspection, routine preventative maintenance and for emergency service. It is imperative that manholes be constructed at locations that will provide convenient access of men and equipment to the manhole.

The preferable location for sanitary sewers is in a dedicated street or alley right-of-way. Where this is impossible or impractical, sewers may be located in permanent easements. Permanent maintenance easements should be adequate in width to allow access and egress of maintenance personnel, vehicles and equipment. Above ground obstructions that are located in the easements such as utility poles, transformers, telephone junction boxes, meters, etc. should be located off center of the easement to avoid interfering with access to and egress from any location over the sewer line. Obstructions belonging to adjacent property owners such as fences, retaining walls, trees, shrubs, utility buildings, etc., should not be permitted on permanent utility easements. The minimum recommended width for permanent maintenance easements for sewers is sixteen feet, with twenty feet being desirable. In sub-divisions where sewers are installed in easements, the sewer should not terminate after being constructed a

short distance past the last lot line in the block, but should instead extend to the street right-of-way for access.

Where sewers are installed in easements, the sewer should be designed so that at least one of the manholes in each straight stretch of sewer is readily accessible in a dedicated street or alley right-of-way. It is highly desirable to have the downstream manhole available whenever possible for cleaning with a high pressure hydraulic sewer cleaner.

3. Drop Type

An outside or inside drop pipe shall be provided for a sewer entering a manhole at an elevation of 24 inches or more above the manhole invert. The outside drop pipe shall be protected against breaking or settling by the use of concrete encasement. For pipe diameters of 8 inches to 12 inches, the drop pipe shall have the same nominal diameter as that of the incoming sewer. For larger pipe sizes, a minimum 12 inch diameter drop pipe shall be provided. The minimum inside diameter of an inside drop type manhole shall be 60 inches.

4. Diameter

The minimum inside diameter of manholes shall be 42 inches. The minimum diameter of manhole entry ways shall be 22 inches.

5. Force Main Receiving Manholes

Brick manholes are recommended for use as force main receiving manholes. Precast reinforced concrete, concrete block, or precast concrete section manholes utilized for this purpose shall have a durable internal coating sufficient to provide protection against corrosion caused by acidic degradation. This coating may be a coal tar compound, an epoxy based compound, or any type of coating of proven quality. Bituminous compounds will not be approved. Extra grouting should also be utilized to provide protection against abrasion.

6. Steps, Rings, and Lids

- a. Manhole steps, rings, and lids shall be made of gray cast iron conforming to ASTM A 48 or shall be made of other corrosion resistant materials. Steps or ladders shall be provided whenever the manhole is deeper than 4 feet. Steps shall be spaced at intervals no greater than 16 inches. Where manhole steps are not utilized, in-place or portable ladders shall be provided.
- b. Manhole rings and lids utilized in traffic areas, i.e., streets, alley-ways, or parking lots, shall be of cast iron construction. Solid manhole covers shall be utilized. Manhole covers with a pickhole are acceptable. Manhole rings and lids of ABS Thermoplastic construction will not be approved.

- c. Manhole rings shall be constructed on manholes so that no infiltration or inflow may enter the manhole.

7. Manhole Bases

- a. Materials for concrete used for manhole bases shall conform, as a minimum, to the following current specifications:

Portland Cement	ASTM C 150
Aggregate for Mortar	ASTM C 144
Fine & Coarse Aggregate	ASTM C 33

Water: Clean and free from deleterious substances. Total water content of concrete shall not exceed 6.5 gallons of water per 100 pounds of cement in the mix.

- b. The base shall be poured of a minimum 3000 psi concrete with a maximum slump of 4 inches, vibrated or tamped. The base shall have a minimum diameter 8 inches greater than the outside diameter of the manhole. The base shall have a minimum 8 inch thickness beneath the manhole wall.
- c. The invert flow channel shall be formed during or immediately after the pouring of the manhole base and brush finished as soon as the concrete has sufficiently set. The flow channel through through manholes shall be made to conform in shape and in slope to that of the sewers. Sewer pipe, with the top half removed, should be laid through the manhole whenever possible.

The inside bottom of the manhole shall rise a minimum of 1 inch per foot from the side of the pipe or the flow channel to the wall of the manhole. Dips or projections capable of holding water or solid materials will not be permitted. The concrete shall set for 24 hours before any pipe inside the manhole is trimmed.

- d. All sewers constructed of rigid or semi-rigid pipe extending from all manholes shall be encased with concrete for a distance of three feet from the outside wall of the manhole. This support may be deleted if a flexible, watertight gasket is used to connect the sewer to the manhole. No support is required for sewers constructed of flexible pipe.
- e. The use of precast concrete attached integral cast manhole bases is approved. Unattached precast concrete bases or pads will be approved only where poor trench conditions warrant their use.

8. Brick Manholes

- a. Brick used for brick manholes shall conform to the current ASTM designations C 32 and C 126.

- b. The minimum manhole wall thicknesses for brick manholes shall be:

At a depth of 0 to 16 ft.	8 inches
At a depth of 16 ft. or greater	12 inches

- c. The manhole shall be waterproofed on the exterior with a minimum cement plaster coating one inch thick or with a minimum plaster coating one-half inch thick in conjunction with one coating of a bituminous or other similar material water proofing compound.

9. Precast Reinforced Concrete Manholes

These manholes shall conform to the current ASTM specifications C 478 except for the following modifications:

- a. Cement used in the construction of precast reinforced concrete manholes shall conform to the requirements of the Standard Specifications for Portland Cement (ASTM Designation: C150).
- b. The minimum shell thickness for precast concrete reinforced manholes shall be:
- | | |
|-----------------------------------|---|
| At a depth of 0 to 16 feet. | One-twelfth internal shell diameter or 4 inches, whichever is greater. |
| At a depth of 16 feet or greater. | One-twelfth internal shell diameter plus one inch, or 5 inches, whichever is greater. |
- c. The bottom precast manhole section shall not be set upon a previously cured manhole base. Pouring 3 to 4 inches of concrete up along the outside walls of the bottom precast section of the manhole is recommended. Where the base extends at least up to 3 to 4 inches along the inside manhole walls, this protection would not be necessary.
- d. Joints between precast reinforced concrete sections shall be of such design that leakage and infiltration can satisfactorily be reduced to a minimum. The use of rubber gaskets (natural or synthetic) and mastics is recommended for this purpose. If mastics are utilized, the joint must be protected on the exterior of the manhole from the degrading action of the soil.
- e. Any precast reinforced concrete section which has been damaged in transit or on site such that the watertightness of the section has been affected adversely shall not be utilized in the construction of the manhole.
- f. The use of 2 or 3 grade adjustment rings or layers of bricks under the manhole cover is recommended especially in undeveloped areas where grade adjustment may become necessary.

10. Concrete Block and Concrete Sections for Sanitary Sewer Manholes

These specifications cover solid, precast, curved or segmental concrete masonry units intended for use in the construction of sanitary sewer manholes.

- a. Materials for concrete block and precast sections shall conform to the following current specifications:

Portland Cement	ASTM C 150
Aggregate for Mortar	ASTM C 144
Steel Reinforcement	ASTM C 617
Concrete Masonry Units	ASTM C 139

The strength of the concrete material shall not be less than 3000 psi.

- b. The wall thickness cannot be less than:

At a depth less than 16 feet	6 inches
At a depth greater than 16 feet	8 inches

- c. The manhole shall be waterproofed on the exterior with a minimum cement plaster coating one inch thick or with a minimum plaster coating one-half inch thick in conjunction with one coating of a bituminous or similar material waterproofing compound.

11. Cast-In-Place Concrete Manholes

- a. Materials for concrete used for cast-in-place concrete manholes shall conform, as a minimum, to the following current specifications:

Portland Cement	ASTM C 150
Aggregate for Mortar	ASTM C 144
Fine and Coarse Aggregate	ASTM C 33

Water: Clean and free from deleterious substances. Total water content of the concrete shall not exceed 6.5 gallons of water per 100 pounds of cement in the mix.

- b. The wall thickness cannot be less than:

At a depth less than 12 feet	6 inches
At a depth greater than 12 feet	8 inches

Shell thickness uniformity shall be obtained through the use of spacers located at the top and bottom of the manhole. For deep manholes, spacers located at a depth of one-half the manhole depth should also be utilized.

- c. The manhole base shall be constructed as required in Section E.7. of this chapter except for the following:

The base shall be poured monolithically with the rest of the manhole. The base shall have a minimum thickness including the area under the pipe as follows:

0 ft. to 8 ft. manhole heights	8 inches
8 ft. to 12 ft. manhole heights	10 inches
12 ft. and above manhole heights	12 inches

G. Cleanouts and Lampholes

1. Lampholes shall not be used.
2. Cleanouts may be used to terminate lines. (See Section F.1. of this chapter.) Cleanouts shall be designed in such a manner as to make any extension of the sewer line impossible without removing the cleanout. The diameter of the cleanout shall be the same as that for the sewer.

H. Protection of Water Supplies

1. There shall be no physical connection between a public or private potable water supply system and a sewer, or appurtenance thereto, which would permit the passage of any wastewater or polluted water into the potable water supply.
2. Sewer lines, i.e., house connections, laterals, trunk lines, interceptors, force mains, etc., shall not be constructed within a 100 foot radius of a public water supply well. Greater separation may be required where soil and drainage conditions indicate the need for greater protection.

Sewer lines constructed of cast iron or solvent welded plastic pipe materials may be constructed within 10 feet of a private water supply well. Sewer lines constructed of non-watertight materials must be at least 50 feet from a private water supply well.

3. A minimum horizontal distance of 10 feet shall be maintained between water and sewer lines. At points where sewers cross water mains, the sewer shall be constructed of cast iron, plastic pipe with solvent welded joints, or pipe encased in concrete for a distance of 10 feet in each direction of the crossing unless the water main is at least 2 feet above the sewer.
4. Water and sewer lines shall not be placed in the same trench or excavation.

I. Outfall Sewers

Outfall sewers and outfall structures shall be designed and constructed to provide:

1. Protection of the sewer against excessive receiving stream velocities, water traffic, floating debris, heavy waves, or other hazards which might damage the structure.
2. Protection of the sewer against the entry of flood water.

VII. SEWAGE PUMPING STATIONS

A. General

Sewage pumping stations shall be protected from flooding. A one hundred (100) year recurrence interval should be considered for design. A suitable superstructure, preferably located off the right-of-way of streets and alleys should be provided. It is important that the station be readily accessible.

B. Type and Capacity

1. Sewage pumping stations should preferably be of the dry well type. Under situations where justification can be provided due to temporary service, economics, construction difficulties, and/or practicability, consideration will be given to the use of wet well mounted or submersible pumping stations. Under no conditions should the operator have to routinely enter the wet well.
2. Sewage pumping stations must be designed to pump the maximum hourly flow. Storage for shorter term peaks can be provided in either the wet well or the upstream collection system, whichever is applicable. If the collection system is to be utilized for storage, care must be taken to insure basements are not flooded. Provisions must also be made so that no untreated wastewater is discharged to a watercourse.
3. The wet well should be designed so that with any combination of inflow and pumping, the cycle of operation of the pumps will not be less than five (5) minutes and the maximum retention time in the wet well will not exceed one hour. Detention periods in the wet well should be kept to a minimum compatible with proper pump operation.
4. Pumping Rates

The pumps and controls of main pumping stations, and especially pumping stations operated as part of treatment plants, should be selected to operate at varying delivery rates to permit discharge of sewage from the station to the treatment works at approximately the sewage flow rate to the pump station.

C. Structures

1. Separation

The wet well and the dry well must be kept separate. The ventilation systems also must be completely separate.

2. Bottom of the Wet Well

The bottom of the wet well should slope to suction lines at least 1.75 vertical to 1.0 horizontal, and the width of the flat bottom

in the wet well should not be more than twice the diameter of the suction bell.

3. Pump Removal

The size of the openings to the ground surface shall facilitate easy removal of pumps, motors, and other large equipment. Lift hooks shall be provided to facilitate removal of pumps and motors. Permanent hoists and hoist rails are acceptable in larger pump stations.

4. Access

Manhole type steps into pump rooms, especially in plants, are undesirable and present a safety hazard. A spiral stairway is considered the minimum acceptable safe means of access to major below-ground structures within sewage treatment plants. Spiral stairways should be used only when conventional stairs cannot be provided. Pumping stations will be approved with access ladders when the facility is too small to justify construction of a stairway.

D. Pumps

1. Number of Required Units

At least two pumps shall be provided, with each pump capable of lifting the maximum design flow. If three or more pumps are provided, the larger unit shall serve as standby equipment with the remaining units capable of accommodating the maximum design flow. If all units are of equal size, then each of the three units shall be capable of pumping one-half the maximum design flow.

For design populations of less than 25 people, pneumatic ejectors and submersible grinder pumps will be considered on a case-by-case basis. If ejector type pumping equipment is utilized, only one reservoir may be utilized but two (2) compressors shall be provided. If submersible grinder pumps are utilized, a minimum of one (1) complete standby pump shall be provided and two (2) complete replacement impellers and cutter units shall be provided.

2. Submersible Pumps

- a. Submersible pumps may be utilized as discussed in section B.1. of this chapter. Submersible pumps should not be utilized in major pump station and raw wastewater treatment facility pump station applications.
- b. Submersible pumps shall be designed specifically for submerged use in raw sewage. An effective method to detect shaft seal failure or potential seal failure shall be provided. Upon detection of moisture leaking past the drive shaft seal, the electrical system shall be designed to turn off the pump and prevent its use in any alternating pump cycle.

- c. Submersible pumps shall be readily removable and replaceable without dewatering the wet well or disconnecting any piping in the wet well.
- d. Electrical supply and control circuits shall be designed to allow disconnection at a junction box located outside the wet well. Terminals and connectors shall be protected from tight seals and shall be protected by separate strain relief.
- e. The motor control center shall be protected by a conduit seal or other appropriate sealing method.
- f. Pump motor power cords shall be designed for flexibility and serviceability under conditions of extra hard usage. Ground fault interruption protection shall be used to deenergize the circuit in the event of any failure in the electrical integrity of the cable.
- g. Power cord terminal fittings shall be provided with strain relief appurtenances, and shall be designed to facilitate field connecting.
- h. Valves shall be located in a separate valve pit. Accumulated water shall be drained to the wet well. An effective method shall be provided to prevent sewage from entering the pit during surcharged wet well conditions. Gate valving on suction will not be required.
- i. All other requirements of this chapter shall apply to submersible pump stations.

3. Pump Openings

Pumps shall be capable of passing spheres of at least three inches in diameter. Pump suction and discharge openings shall be at least four inches in diameter. These requirements are not applicable to grinder type pumps.

4. Priming

The pump shall be so placed that under normal operating conditions it will be self-priming. Vacuum prime pumps shall be considered self-priming.

5. Electrical Equipment and Controls

Electrical equipment in enclosed places where gas may accumulate shall comply with the National Board of Fire Underwriters specifications for hazardous conditions.

Control systems should be simple, direct, and reliable, utilizing a centralized control panel. Consideration should be given to installation of proper instrumentation such as pressure gages, flow recorders or indicators, and electrical devices such as voltmeters, wattmeters, and ammeters.

6. Intake

Each pump should have an individual intake. Wet well design should be such as to avoid turbulence near the intake. Bell mouth inlets should be utilized when feasible.

7. Dry Well Dewatering

A separate sump pump shall be provided in dry wells to remove leakage or drainage. Discharge of the sump pump shall be at an elevation which would not allow sewage to drain to the dry well. Water ejectors connected to a potable water supply will not be approved. All floor and walkway surfaces should have an adequate slope to a point of drainage. Check valves should be provided on the sump pump discharge line to avoid flooding of the dry well during periods of extended electrical power failure.

E. Force Mains & Piping

1. Velocity and Force Main Size

The velocity at design flow shall be in excess of two feet per second. A maximum velocity of 10 feet per second is suggested for discharge lines. The minimum acceptable size for a force main shall be 4 inch nominal diameter. Smaller size mains will be considered with grinder pump installations where the reduced pipe size is necessary to insure a flushing velocity of 2 feet per second.

2. Suction Line

The suggested maximum velocity in suction lines is 10 feet per second.

3. Valves

Shut-off valves should be provided on the suction and discharge side of each pump so the pump may be easily removed. Check valves shall be placed on each discharge line between the shut-off valve and the pump.

4. Air Relief Valve

Air relief valves should be placed at high points in the force main to prevent air locking. Manual relief valves are recommended for this purpose. Automatic relief valves will be approved only where their use can be justified.

5. Termination

Special consideration should be given to the design of force main outlets to avoid unnecessary splashing and retard erosion.

6. Materials and Joints

Acceptable materials for force main construction include cast iron, ductile iron, asbestos-cement, and solid wall plastic. Acceptable force main joints are mechanical, push-on or rubber compression gaskets for CIP, AC and DIP; solvent welded and compression gaskets for plastic pipe.

7. Reaction Blocking

Reaction blocking or restrained joints shall be provided at bends in force mains where the bend exceeds $11\frac{1}{2}^{\circ}$.

F. Power Supply

Electrical power should be available from at least two independent sources, or emergency power equipment should be provided. Where this is not feasible, an overflow and storage catchment system shall be provided at such an elevation as to prevent basement flooding. If the pump station and collection system can provide 12 hours or more of wastewater storage at average design flow without basement flooding or bypassing, then emergency power or additional catchment facilities may not be required. In any situation, provisions must be made so that no untreated wastewater will be discharged to a watercourse.

Where permanently installed or portable engine-driven pumps are used, the following requirements shall apply. Engine driven pump(s) shall meet the design pumping requirements of the station unless storage capacity is available for flows in excess of pump capacity. Pumps shall be designed for anticipated operating conditions, including suction lift if applicable. Where part or all of the engine driven pumping equipment is portable, sufficient storage capacity to allow time for detection of pump station failure and transportation and hookup of the portable equipment shall be provided. A riser from the force main with quick connection coupling and appropriate valving shall be provided to hook up to the portable pumps.

G. Alarm System

Alarm systems should be provided for all pumping stations. The alarm shall be designed to activate at the onset of pump or pump station malfunction. The use of audio or visual alarms shall be evaluated in terms of effectiveness in alerting operation and maintenance personnel of pump station malfunction. Telecommunication systems are recommended for large pump stations. The alarm system must be operable independent of the primary and any secondary power sources.

H. Ventilation

Forced air ventilation shall be provided for all below-ground level pumping station dry wells. Ventilation, if continuous, shall provide at least 6 complete air changes per hour; if intermittent, at least 30 complete air changes per hour. Intermittent systems shall be activated upon entrance into the dry well. Alternative ventilation systems in larger facilities may be utilized. Wet wells require forced air

Sewage Pumping Stations
Adopted 8-17-78

ventilation only when the wet well contains equipment (bar screens, comminutors, etc.) which require regular maintenance or inspection. The equipment shall be automatically activated upon opening the well cover. Atmospheric vents shall be provided when forced air ventilation systems are not required to avoid accumulation of toxic and combustible gases.

VIII. PRIMARY TREATMENT

- A. Primary treatment is considered to include all treatment preliminary to biological treatment and includes comminutors, bar screens, grit removal, pre-aeration, and sedimentation.
- B. Screening
 - 1. Purpose
 - a. Screening is used to economically remove large solids from wastewater which would damage equipment or interfere with subsequent treatment processes. Bar screens are typically used prior to pumping or preceeding grit chambers or sedimentation basins. When comminutors are used it is necessary to place an alternate channel equipped with a bar screen to provide protection when the comminutor is temporarily removed from service or when high flows are experienced.
 - 2. Design of Bar Screens
 - a. Bar screens shall be used in conjunction with comminutors, grit chambers and major pump stations where impairment of pumping will jeopardize the entire treatment process.
 - b. Bar screens located in deep structures should utilize mechanical removal of screenings. As a minimum, a mechanical means of raising screening containers to ground level must be provided.
 - c. When bar screens are located in a structure which contains office or maintenance space, the bar screen should be separated from the rest of the building and should be provided with a separate outside entrance and ventilation.
 - d. Manually cleaned bar screens should maintain a velocity through the screen of approximately one foot per second at average rate of flow. For mechanically cleaned screens, maximum velocities during wet weather periods should not exceed 2.5 feet per second. The velocity shall be calculated from a vertical projection of the screen openings on the cross-sectional area between the invert of the channel and the flow line.
 - e. The screen channel invert should not be more than 6 inches below the invert of the incoming sewer.
 - f. The inverts in chambers containing screening devices shall be shaped to minimize deposition of solids and to provide for ease of operation.
 - g. Hand-cleaned screens should be placed on a slope of 30 to 45 degrees with the horizontal.

- h. Channels shall be equipped with the necessary gates to divert flow from any one screening unit. Provisions also must be made for dewatering each unit.
- i. The clear opening between bars of manually cleaned screens should be between 1 to 2 inches.
- j. The clear openings for mechanically cleaned screens may be as small as 5/8 of an inch.
- k. The net area of the bar screen openings shall be at least 150 percent of the area of the incoming sewer.
- l. Where mechanically operated screening or comminuting devices are used, auxiliary hand-cleaned screens shall be provided. The design shall include provisions for diversion of the entire sewage flow through the auxiliary screens should the regular units fail to operate.
- m. Containers with tight fitting covers shall be provided for storage of screenings prior to ultimate disposal. Hand-cleaned screening facilities should include an accessible platform from which the operator may rake screenings easily and safely. Suitable drainage facilities back to the raw sewage wet well should be provided both for the platform and for the storage area. Acceptable methods of screenings disposal are burial or incineration.

C. Grit Removal Facilities

- 1. The function of grit removal facilities is to remove inert non-biodegradable particles larger than 0.2 mm in size. The intent of grit removal facilities is to (a) provide protection for mechanical equipment from excessive wear, (b) reduce pipe clogging, (c) reduce the frequency of anaerobic digester maintenance, and (d) improve digester operation.
- 2. Grit removal facilities should be provided for all mechanical sewage treatment plants and must be provided for all plants incorporating anaerobic digestion or if the collection system contains combined sewers. Consideration should be given to future addition of grit removal facilities for all mechanical plants.
- 3. Where practical, grit removal facilities shall be located ahead of pumps and comminuting devices.
- 4. The type of grit chamber to be utilized is dependent upon the nature of the collection system and industrial waste contributors. Three types of grit removal facilities are acceptable and are as follows: (a) channel type, (b) aerated grit chambers, (c) circular-short detention (Vortex) type. Application will depend upon size of plant and physical space available.

5. Design of Channel-Type Grit Chambers

- a. Grit channels shall be designed to provide controlled velocities between 0.5 and 1.0 feet per second with a minimum of inlet and outlet turbulence.
- b. Detention time in a channel shall be based on the size and specific weight of the particles to be removed. The channel must be long enough for a particle of 0.2 mm in size to settle from the wastewater surface to the bottom of the channel. A particle of this size will settle at about 1.0 inch per second. The design shall provide a minimum of two channels operated in parallel with gates to independently remove each channel from service.
- c. Grit shall be removed from the basin by mechanical means. The time and frequency of operation should be flexible and controlled by the operator.
- d. Suitable care shall be taken in the design to minimize the amount of grit handling. If possible, the grit should be discharged directly to a transfer vehicle.

6. Design of Aerated Type Grit Chambers

- a. Grit chambers which use air are affected less by fluctuations in sewage flow than are channel type units. The reason for this is that velocities within the chamber are established by the air added to the chamber. The design is based upon the rate of air addition required to establish flow velocities that will remove grit particles 0.2 mm and over while not removing organic matter.
- b. The minimum detention time in the chamber shall be 3 minutes at the maximum design flow.
- c. Chambers should have a depth to width ratio of 2 to 1 or larger and in no case shall be less than 1.5 to 1.
- d. The minimum air requirement is 3 cubic feet per minute per foot of chamber length when the total depth of the basin is approximately 10 to 12 feet. Higher air rates per foot are required for wider and deeper installations.
- e. The location of the air diffusion tubes should be approximately two to three feet from the bottom of the chamber and along its side, parallel to the wastewater flow, provided that the total depth of the basin is approximately 10 to 12 feet.

7. Design of Vortex Grit Chambers

- a. The vortex grit removal chamber design incorporates an impeller and a tangential inlet to provide a spiral flow

pattern. The flow pattern moves the grit to a center chamber for removal.

- b. The detention time shall not be less than 1 minute at maximum design flow. Flow velocities shall be between 1.0 and 2.0 feet per second.
- c. Grit shall be mechanically removed via a screw conveyor or air lift pump.
- d. The impeller shall be variable speed, adjustable between 10 and 45 revolutions per minute. The designer may or may not wish to inject air to improve grit cleaning.
- e. As more design information becomes available, the design criteria for vortex grit chambers will be modified accordingly.

8. Grit Removal

Grit chambers should be provided with mechanical or air lift grit removal systems. Grit chambers located below ground level must have mechanical grit removal equipment. A stairway or approved-type elevator or manlift, adequate ventilation and adequate lighting must also be provided. In the design of grit removal facilities, the designer should minimize the amount of effort required for grit removal. In plants larger than 5.0 MGD, the grit should be discharged directly via mechanical means to a transport vehicle.

9. Grit Handling

Impervious surfaces with drains should be provided for grit handling areas. These drains should drain back to the wastewater treatment facility prior to any primary or secondary treatment process. If grit is to be transported, the conveying equipment should be designed to avoid loss of material and protect from freezing.

D. Pre-Aeration and Flocculation

Pre-aeration of sewage before primary sedimentation is worthy of consideration when either the incoming flow is septic or when high organic strength and suspended solids may result in a septic condition. The pre-aeration basin may be combined with an aerated grit chamber and grit removal facilities in the first portion of the basin.

1. Arrangement

Pre-aeration units should be designed so removal from service will not interfere with normal operation of the remainder of the plant.

2. Design

- a. Basin shapes should be coordinated with the type of aeration equipment employed. Mechanical surface or turbine aerators should utilize circular basins. Rectangular basins should be used with diffused aeration. Care should be taken to minimize short-circuiting. Corners shall be filleted to reduce solids depositions and facilitate circulation.
- b. When coagulant aids are utilized, a minimum detention time of 30 minutes must be provided. A desirable feature is a short detention time - high energy input mixing basin for coagulant aid dispersion. The mixing basin should have a detention time no longer than 3 minutes.
- c. A maximum primary treatment efficiency of 40 percent BOD reduction may be allowed when pre-aeration is used. When this BOD removal allowance is claimed, a minimum detention time of 45 minutes must be provided for average design flow.
- d. A minimum firm blower capacity of 1500 cubic feet of air per 100 cubic feet of wastewater shall be provided for diffused air systems. A minimum of 1.0 horsepower per 1000 cubic feet of wastewater shall be provided for mechanical aerators.

E. Sedimentation Basins

Note: Details pertaining to final clarifiers are covered in the chapter entitled "Mechanical Biological Treatment".

1. Inlets

Inlets shall be designed to dissipate the inlet velocity, to distribute the flow equally, and to prevent short-circuiting. Inlet channels shall be designed to maintain a velocity of at least two feet per second at average design flow. Corner pockets and dead ends must be eliminated in inlet channels.

2. Dimensions

The length-to-width ratio for rectangular basins should be greater than or equal to 4 to 1. The minimum diameter for circular clarifiers shall be 20 feet. The minimum length from flow inlet to outlet should be 10 feet unless special provisions are made to prevent short-circuiting. The liquid depth of mechanically cleaned primary settling tanks shall be as shallow as practicable but not less than 8 feet. The minimum depth of all settling basins should be such that the sludge collector scraping mechanism will be at least 6 feet below the water level.

3. Scum Removal

Effective scum collection and removal facilities, including baffling, shall be provided ahead of the outlet weirs on all

primary settling tanks. Provisions may be made for discharge of scum with the sludge. Other provisions, such as incineration, may be used to dispose of floating materials which may adversely affect sludge handling and disposal. Scum baffles are required around all effluent weirs.

4. Multiple Tanks

Multiple units shall be provided unless removal from service of a single unit for repairs will not result in objectionable conditions, physical damage, or adversely affect receiving stream quality. Multiple units capable of independent operation shall be provided for systems having a design population equal to or greater than 10,000 P.E.

5. Protective and Servicing Facilities

All settling tanks shall provide easy access for maintenance and protection to operators. If side walls are extended some distance above the ground level to provide flood protection or for other purposes, convenient walkways must be provided to facilitate housekeeping and maintenance.

6. Sludge Removal

Sludge storage prior to removal from the basin shall be in appropriately located hoppers. Each sludge hopper shall have an individually valved sludge withdrawal line at least 6 inches in diameter. Sludge hoppers shall be accessible for maintenance from the operating level. The minimum slope of the side walls of sludge hoppers shall be 1.5 vertical to 1 horizontal. Clearance between the end of the sludge drawoff pipe and the hopper walls shall be sufficient to prevent "bridging" of solids. Hopper bottoms shall have a maximum dimension of 2 feet. The head available for withdrawal of sludge shall be at least 30 inches if removal is dependent upon gravity flow.

Positive displacement or progressing cavity pumps shall be provided for pumping primary sludge. Automatic control shall be provided for sludge pumps and sludge collecting mechanisms.

7. Detention Time, BOD Removal and Surface Overflow Rates

a. A minimum detention time of 2 hours is required at the average rate of flow. Not more than 30 percent BOD reduction can be considered when designing subsequent units, unless industrial wastes containing unusually high concentrations of settleable organic solids are being treated. Requests for variations to this guideline must be accompanied by laboratory and/or pilot plant analysis.

b. The maximum surface overflow rate at average daily flow shall be 1000 gpd/sq. foot.

IX. MECHANICAL BIOLOGICAL TREATMENT

A. Trickling Filters

1. Applicability

Trickling filters may be used where the wastewater is amenable to biological treatment. Single stage rock media trickling filters will not be approved for new facilities. Trickling filter influent must be relatively free from settleable, floating, or suspended solid matter which would tend to plug filter media interstices.

Trickling filters provide relatively good performance with a minimum of skilled technical supervision. Trickling filters are normally constructed in conjunction with a final clarifier to remove suspended solids.

2. Design Basis

- a. Trickling filters are termed standard rate and high rate on the basis of hydraulic and biological loading as follows:

	Hydraulic Loading		Organic Loading	
	Gallons per sq. ft. per day	MGAD*	Pounds BOD ₅ per 1000 cu. ft. of media per day	Pounds BOD ₅ per acre ft. of media per day
Standard Rate	45-90	2-4	10-20	450-950
High Rate	250-700	10-30**	30-100	1300-4300

*Million Gallons Per Acre Per Day

**Including Recirculation

- b. High rate trickling filters may be used as a roughing filter prior to further biological treatment. High rate systems are capable of withstanding highly variable hydraulic overload conditions without significant deterioration of the biological growth.

3. Design Calculations

A comprehensive discussion of all functional design calculations used in sizing trickling filter facilities shall be included in the facilities plan and/or be submitted separately for review and approval. This discussion shall include the following:

- Influent wastewater characteristics.
- Temperature range of applied wastewater.
- Pretreatment of the waste, if any.

- d. Type of filter; two stage, standard rate or high rate, artificial, wood or rock media.
- e. Hydraulic and organic loading applied to the filter.
- f. Recirculation - ratio and system.
- g. Filter beds, volume, area and depth.
- h. Media, type, specific weight, void space.
- i. Aeration, underdrain and ventilation.
- j. Equations used to compute treatment efficiency.
- k. Degree of treatment anticipated.

4. Distribution of Waste

Devices for distributing the wastewater shall be designed to obtain uniform flow distribution over the surface of the entire media. Flow distribution devices shall be designed to provide a variation of less than 10 percent in the rate of liquid application to different parts of the media surface under average daily flow conditions.

5. Clearance

A minimum clearance of 12 inches should be provided between the upper surface of the media and any moving parts of the distributor arms.

6. Dosing

Dosing siphons or similar intermittent flow devices are required to properly distribute flows for low rate filters when the use of recirculation is absent. The maximum interval between dosings shall not exceed 3 hours for low rate filters. The provision of continuous application of sewage to the filter media is strongly recommended by the use of recirculation. The surface of the media of a high rate filter should be dosed at least once every minute.

7. Media

a. Quality

The media may be crushed rock, rounded gravel, redwood, or specially manufactured artificial material. The media should be durable to weathering, resistant to spalling or flaking and be insoluble in the wastewater being treated. The material should be free of fine particles, grease and oil and also should be properly screened and/or washed to remove dust and dirt before placement.

If rock media is used, the top 18 inches shall have a loss by the 20-cycle, sodium sulfate soundness test of not more than 10 percent. The balance of the media shall pass a 10-cycle sodium soundness test using the same criteria. All tests shall be conducted as prescribed by ASCE 13. Synthetic media shall be structurally stable and chemically and biologically inert. Specific attention should be given to the distribution pattern in artificial media.

b. Size

Rock and similar media shall be as uniform in size as possible and when tested with standard laboratory sieves having square openings, shall conform to the following listed gradings for both high rate and low rate filters:

Percent Retained Per Screen Size

Passing 4 1/2 inch screen	100% by weight
Retained on 3 inch screen	95% - 100% by weight
Passing 2 inch screen	0 - 2% by weight
Passing 1 inch screen	0 - 1% by weight

c. Depth

The minimum depth for the filter media shall not be less than 6 feet for low rate and high rate filters. Depths of up to 22 feet may be used for synthetic media. Use of greater depths may be allowed based upon presentation of additional engineering data.

d. Handling and Placing of Media During Construction

Material delivered to the filter site shall be stored on wooden planks or other approved, clean, hard surfaces. All material shall be rehandled at the construction site and no material shall be dumped directly into the filter. Crushed rock and similar media shall be rescreened or forked at the filter site to remove all fines. Such material shall be placed by hand to a depth of 12 inches above the underdrains. The remainder of the material may be placed by means of belt conveyors or similar methods approved by the engineer. Trucks, tractors, or other heavy equipment shall not be driven over the filter during or after construction.

8. Underdrains

Underdrains of low rate filters should be sized to permit conversion of the filter to a high rate system.

a. Subfloor

The floor of the filter shall be able to support the underdrainage system, the filter media, and the water load. A

minimum one percent gradient shall be provided for the sub-floor to slope to a drainage channel.

b. Filter Block

Precast filter blocks, made of vitrified clay or concrete should be used. The invert of the filter blocks is generally semicircular and the minimum opening in the upper face should be 20 percent of the surface of the block. Redwood timbers resting on concrete sleepers can be used in the place of filter blocks, when redwood media is provided.

c. Drainage Channel

The drainage channels shall provide capacity to carry the flow from the underdrains and to admit air to the underdrains for ventilation. Channels should be sloped to provide a minimum flow velocity of 2 feet per second. The water level in the drainage channel should be below the bottom of the underdrain blocks during maximum flow condition.

d. Ventilation

50% of the cross-sectional area of underdrain and drainage channels should remain unsubmerged at maximum hourly flows. The use of adjustable ventilation ports which may be utilized for cleaning purposes is encouraged.

9. Structural Enclosure

a. Walls

The media and underdrain system shall be enclosed by a structure capable of holding water and designed to prevent entrance of blowing foreign material. This structure may be constructed of concrete, vitrified clay, concrete blocks, or other approved material. The wall structure shall be designed such that a cover, dome, etc., may be placed over the trickling filter at a later date.

b. Freeboard

A minimum freeboard of two feet should be provided on the structure wall to prevent splashing and to protect the distributor against buffeting from high winds.

c. Flooding

All filters, other than ones utilizing artificial media, with a sidewall depth less than six feet should be designed to permit hydraulic flooding of the filter media. This is particularly important for low rate filters.

10. Maintenance

All distribution devices, underdrains, channels, and pipes should be installed so that they may be flushed, drained, and cleaned. At least one cleaning port will be located in the sidewall of the trickling filter such that the distributor arm(s) may be cleaned without removal.

11. Recirculation

The use of effluent liquid recirculation is strongly recommended to maintain an active biological growth at all times and to increase overall efficiency. A proper recirculation ratio should be selected for the design of the system (i.e., ratio of recirculated flow to the primary effluent).

a. Pumps for Recirculation

Adequate pumping capacity to pump the design rate of recirculation with a ± 50 percent varying capacity should be provided. A standby unit shall be provided when intervals longer than 3 hours would occur between dosings without the presence of recirculation.

b. Flow Measurement

A device to measure the recirculation flow shall be provided, accurate to within $\pm 5\%$.

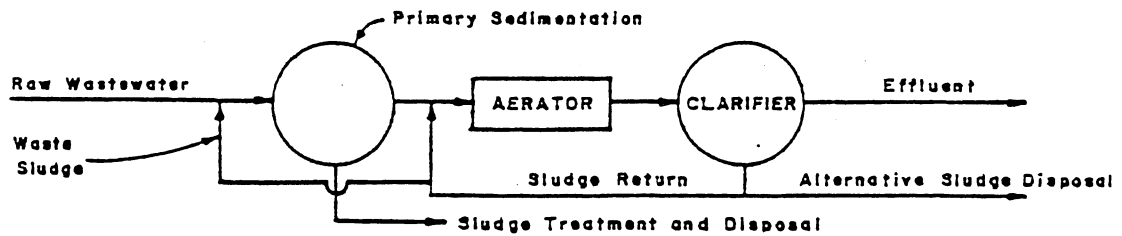
B. Activated Sludge

1. The activated sludge process and its various modifications may be used where the wastewater is amenable to biological treatment. The activated sludge process is a biological wastewater treatment process in which a mixture of wastewater and biologically active sludge is agitated and aerated. The activated sludge is subsequently separated from the mixed liquor by sedimentation and wasted or returned to the process as needed. The most meaningful division of this process can be made according to the flow regime in the aeration tank. The two extremes are: (1) plug flow and (2) complete mixing. The major modifications of the activated sludge process included in this section are, the conventional process, which operates in the plug flow regime; step aeration, and contact stabilization which operate as an intermediate flow condition between plug flow and complete mix; and complete mixing. The completely mixed flow regime activated sludge process includes a variety of systems ranging from the high rate process to extended aeration. Examples of the foregoing variations are shown in Figure I.

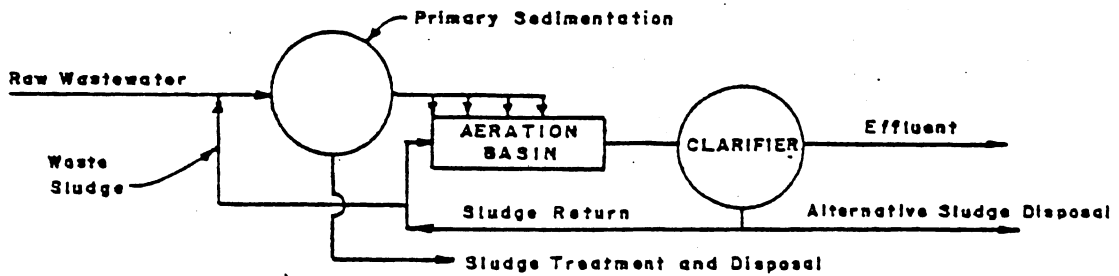
2. Specific Process Selection

The activated sludge process and its modifications may be applied to accomplish varied degrees of removal of suspended solids and

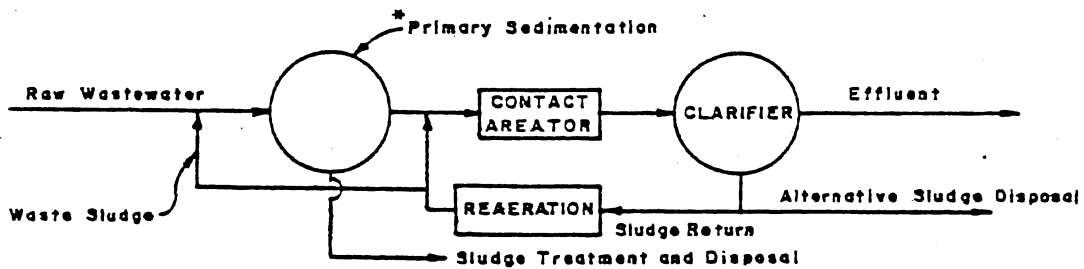
FIGURE I
ACTIVATED SLUDGE-PROCESS SCHEMATICS



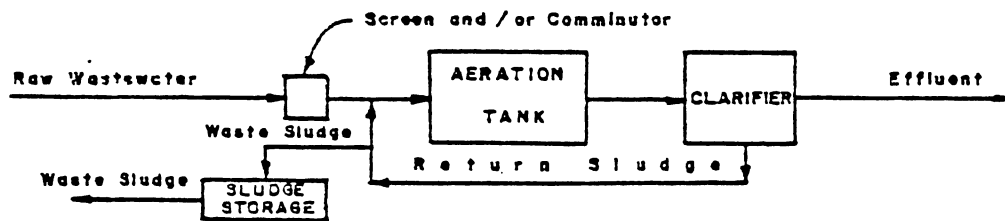
CONVENTIONAL ACTIVATED SLUDGE PROCESS



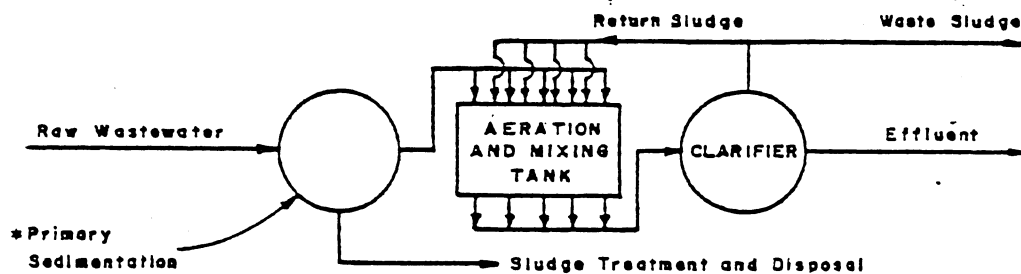
STEP AERATION



CONTACT STABILIZATION PROCESS



EXTENDED AERATION PROCESS



COMPLETE MIX ACTIVATED SLUDGE

* Primary Sedimentation can be omitted, the use of Screen or Comminutor is necessary.

reduction of BOD. Choice of the process most applicable will be influenced by the proposed plant size, type of waste to be treated and degree and consistency of treatment required. All designs shall provide for flexibility in operation. The process requires competent operating supervision and routine laboratory control.

3. Pretreatment

Where primary settling tanks are not used, effective removal of excessive grit, debris, excessive oil and grease, and comminution of solids should take place before the waste enters the aeration basin by the provision of appropriate pretreatment facilities.

4. Design Calculations

A comprehensive discussion of all functional design calculations used in sizing activated sludge treatment facilities shall be included in the facilities plan and/or be submitted under separate cover for review and approval.

This discussion shall include:

- a. Influent wastewater characteristics.
- b. Temperature range of wastewater.
- c. Pretreatment of the waste, if any.
- d. Hydraulic and organic loading applied to the aeration basin.
- e. Anticipated mixed liquor suspended solids level to be maintained in the aeration basin.
- f. Aeration time.
- g. Oxygen and mixing requirements for average and peak flows.
- h. Recirculation and sludge wasting.
- i. Degree of treatment anticipated.
- j. Equation(s) used to compute treatment efficiency.

5. Aeration

a. BOD Removal

The activated sludge process and its modifications may be expected to remove from 85 to 95 percent of the BOD applied to the aeration tanks. If tertiary system design is necessitated, activated sludge should be used in the biological portion.

b. Aeration Tanks

The size of the aeration tank for any particular adaption of the process should be determined by rational calculations based on such factors as the size of the plant, degree of treatment desired, mixed liquor suspended solids concentrations, BOD_5 loading to mixed liquor suspended solids ratio, and final settling basin provided. (See table on following page.)

1. Dimensions of Aeration Tanks

The dimensions of each independent aeration tank or return sludge reaeration tank shall be such as to maintain effective mixing and utilization of air. Liquid depths should not be less than 10 feet except in special cases. For very small tanks or tanks with a special configuration, the shape of the tank and the installation of aeration equipment should provide for positive control of short-circuiting through the tank.

2. Shape

The shape of the aeration basin is dependent upon the type of aeration equipment provided. The goal of shape selection is to maximize mixing and minimize solids deposition. In general, if diffused aeration is used, rectangular tanks are recommended. If mechanical aeration is used, a circular shape is recommended.

3. Multiple Units

Multiple tanks capable of independent operation are recommended and shall be provided for all activated sludge wastewater treatment installations serving a design population equal to or greater than 10,000 P.E.

4. Inlets and Outlets

a. Controls

Inlets and outlets for each aeration tank unit shall be equipped with valves, gates, stop plates, weirs or other devices to permit controlling the flow to any unit. The hydraulic properties of the system should permit the maximum instantaneous hydraulic load to be carried with any single aeration tank unit out of service; provided, that the design capacity is equal to or greater than 10,000 P.E.

b. Conduits

Channels and pipes carrying liquids with solids in suspension shall be designed to maintain a minimum

Mechanical Biological Treatment
Adopted 8-17-78

The following minimum tank capacities shall be provided for the various modifications of the activated sludge process based on average daily flow:

Summary Table of Aeration Tank Capacities and Permissible Loadings for Activated Sludge Processes

Type of Process	Aeration Detention ¹ Time - Hours	Aeration Tank ²		Pounds BOD ₅ Per Pounds MLSS
		Loading, lbs. BOD ₅ Per 1000 cu. ft. per Day		
Conventional	6 - 8	30 - 40		0.25 - 0.50
Step Aeration	6 - 8	30 - 50		0.17 - 0.50
Contact Stabilization	$\frac{1}{2}$ to 1 in contact chamber 2 to 6 in stabilizer	30 - 50 ³		0.125-0.50 in contact chamber, 0.05-0.10 in stabilizer.
Extended Aeration	24	15 - 30		0.05 - 0.10
Complete Mix	3 - 24	20 - 60		0.05 - 1.0

- ¹ Larger values for smaller plants, up to 5,000 P.E. design capacity.
² Larger values for larger plants with larger than 5,000 P.E. design capacity
³ Total BOD₅ , in the contact chamber and the reaeration zone.

velocity of two feet per second or shall be agitated to keep such solids in suspension.

c. Baffling

Care must be taken in the design to prevent the entire basin contents from rotating while under aeration. The use of baffles is recommended to prevent rotation especially in circular basins.

5. Freeboard

Normally all aeration tanks shall have a freeboard of not less than 18 inches. Greater freeboard is desirable. Suitable water spray systems or other means of froth and foam control should be provided.

C. Aeration Equipment

1. General

Oxygen requirements generally depend on BOD loading, degree of treatment, waste characteristics, and the suspended solids concentration maintained in the aeration tank mixed liquor. Aeration equipment shall be capable of maintaining a minimum of 2.0 mg/l of dissolved oxygen under average design conditions. The aeration equipment must be capable of maintaining 0.5 mg/l of dissolved oxygen under all conditions. Suitable protection from the elements shall be provided for electrical controls.

Aeration equipment shall be provided in duplicate with each aeration unit equal to the total aeration requirement; or if two units are utilized to supply total aeration requirements, a third unit equal to the largest unit in service shall be supplied as standby equipment. Where mechanical aeration is specified, the minimum standby unit shall consist of the aerator motor and gear reduction unit. Provision shall be made for rapid replacement in case of mechanical failure.

2. Diffused Air Systems

- a. Air requirements shown in the following table will be considered normal requirements. In general, the requirements previously outlined shall be met.

MINIMUM AIR TO BE APPLIED

Activated Sludge Process	Cubic Feet Per Pound BOD ₅ Aeration Tank Load (Standard Pressure*)
Conventional	1000
Step Aeration	1000
Contact Stabilization	1500
Extended Aeration	2000
Complete Mix	1500

*Based on five percent transfer efficiency.

- b. The preceding requirements assume equipment capable of transferring at least 1.23 pounds of oxygen at STP (20°C Temperature, 0 mg/l D.O., 14.7 psia.) to the mixed liquor per pound BOD₅ aeration tank loading. Additional requirements for air lift pumps etc., shall be added to the above.
- c. The specified capacity of blowers or air compressors, particularly centrifugal blowers, should take into account the air intake temperature which may be expected to reach 40°C (140°F) and the atmospheric pressure which may be as much as 10 percent less than normal. The specified capacity of the motor drive should also provide for intake air temperature as low as -25°C (-13°F). Heat damage to the motor under these conditions should be prevented by either oversizing the motor or by providing a means of reducing the rate of air delivery.
- d. The blowers shall be provided in multiple units, so arranged and in such capacities as to meet the maximum air demand with the single largest unit out of service. It is recommended that the design also provide for varying the volume of air delivered in proportion to the load demand of the plant.
- e. The air diffusion piping and diffuser system shall be capable of delivering 150 percent of normal air requirements. The spacing of diffusers should be in accordance with the oxygenation and mixing requirements throughout the length of the channel or tank. The system should be designed to facilitate adjustments of diffuser spacing without major revision of air header piping. Diffusers shall also be designed to permit removal for inspection, maintenance and replacement without dewatering the tank and without shutting off the air supply to other diffusers in the tank. Individual diffusers shall be readily removable for cleaning and maintenance purposes.
- f. Individual assembly units of diffusers shall be equipped with control valves, preferably with indicator markings for throttling, or for complete shut off. Diffusers in any single assembly shall have substantially uniform pressure loss to provide that the pressure in the air main supplying a tank should remain nearly constant throughout the length of the tank. The drop in pressure should not exceed 1.5 inches of water from one end of the header to the other.
- g. The compressor system shall be provided with a noise suppression system to limit noise to 95 dB at a five foot distance.
- h. Air filters shall be provided in numbers, arrangement, and capacities to furnish at all times an air supply sufficiently free from dust to prevent clogging of the diffuser system used. The minimum capacity of air filters should be adequate to meet the blower capacity.

3. Mechanical Aeration Systems

- a. All components of the aeration unit shall be designed for the expected conditions in the aeration tank in terms of the proven performance of the equipment.
- b. Consideration should be given to protecting, to the greatest extent possible, the unit from excessive ice coating during inclement weather.
- c. Multiple mechanical aeration unit installations shall be so designed as to meet air demand with the largest unit out of service. Provision for rapid replacement must be provided. The design should also provide for varying the amount of oxygen transferred in proportion to the load demand on the plant. If depth of submersion is an important criteria, the aeration system shall be adjustable or the basin levels shall be readily controllable with regard to depth.

4. Turbine Aeration

- a. If turbine aeration is proposed, the design engineer will submit engineering data concerning the mixing, oxygen transfer, efficiency, and other pertinent characteristics.

5. Mixing Requirements

- a. For all systems, a liquid waste turnover time shall be provided such that a minimum velocity of 1.0 fps is available at all points in the basin to prevent deposition of solids.

6. Testing Requirements

Consideration should be given to the use of field testing of mechanical and diffused aeration systems where the proposed system is "new" technology, where manufacturer's data is limited, or where the nature of the wastewater is critical. The Water Pollution Control Section, Bureau of Water Quality may require testing on larger installations or installations treating exotic or critical wastewaters.

D. Oxidation Ditches

The oxidation ditch is a modified form of the activated sludge process and may be classified in the complete mix extended aeration group. This type of facility can produce BOD₅ reductions of 90 percent or greater.

1. Pretreatment

There is normally no primary settling tank used in this process. Bar screens and comminutors are required for the protection of the mechanical equipment such as the rotors and pumps. If large amounts of grit are present in the influent to the plant, a grit chamber should be employed.

2. Oxidation Ditch

The oxidation ditch forms the aeration basin where the wastewater is mixed with return sludge.

- a. The volume of the oxidation ditch is to be sized on a minimum of 75 cubic feet per pound of BOD₅ applied daily. Regardless of the loading, the ditch should have a minimum detention time of 18 hours; 24 hours is recommended.
- b. The ditch will be designed to operate at a minimum depth of 3 feet.
- c. A minimum of 1 foot of freeboard is to be provided at maximum water depths.
- d. The ends of the ditch should be well rounded to prevent eddying and quiescent areas. The median strip should be such that the radius of curvature is not severe. An excessive radius of curvature increases the frictional resistance and can retard the liquid flow. Baffling may be utilized to aid the reduction of quiescent conditions.
- e. It is recommended that a trapezoidal cross-sectional be employed. Vertical wall basins may be utilized depending upon the design situation.
- f. The ditch may take any linear shape as long as it forms a closed circuit, and does not produce any eddies or dead spots. Minimizing the number of bends in the ditch is suggested.
- g. A minimum velocity of 1 fps is to be maintained throughout the length of the ditch.
- h. The ditch will be constructed of concrete. The recommended concrete thicknesses are a minimum of 4 inches in thickness for ditches up to 5 feet deep and a minimum of 6 inches in thickness for ditches deeper than 5 feet. Adequate reinforcing wire mesh or steel shall be utilized.
- i. If return baffles (concrete) are utilized, it is recommended that they be placed immediately below the water surface to reduce maintenance.
- j. Rotor weight shall not be supported directly by gear reduction or motor equipment. Intermediate bearings between dual rotor installations should not be utilized unless sufficient protection and access to the bearing assembly is provided.
- k. Motors, gear reduction equipment, bearings, etc., shall be protected from inundation and rotor spray.

3. Rotor Aerators

- a. A minimum of two complete rotor installations (in place) are to be provided such that a single rotor installation can provide the average design oxygen demand. Both rotor installations should provide the peak oxygen demand produced by organic and/or hydraulic loads.
- b. The rotors should be located such that a long straight section is provided downstream of the rotor. The direction of flow should be toward the long straight section.
- c. Capabilities of either varying the water level or rotor submergence depth shall be provided. An adjustable effluent weir is suggested.

4. Final Sedimentation Tank

- a. The design criteria outlined in section F. of this chapter shall apply.

5. Sludge Return

- a. Provisions for sludge return shall be provided.
- b. The return sludge pump should be sized to return at least 100 percent of the design flow. Consideration should be given to regulating the rate of return sludge.
- c. The return sludge should be introduced directly upstream of the rotor(s) and downstream of the effluent withdrawal point.
- d. All excess sludge should be disposed of by means outlined in the chapter entitled "Land Application of Wastewater Effluent or Sludge".

6. Miscellaneous

- a. The wastewater influent should be introduced directly upstream of the rotor(s) and downstream of the effluent withdrawal point.
- b. Walkways across the ditch shall be provided for maintenance of the rotor(s). Walkways shall not be placed directly above rotor installations or close enough to be affected by spray, ice, etc., or to hinder removal of the rotor.
- c. Piping should be arranged such that the oxidation ditch or the final clarifier may be bypassed, without the bypassing of raw wastewater.
- d. All designs for oxidation ditch facilities shall include safety guard rails around the ditch interiors and exteriors.

The guard rails shall be designed for easy removal where necessary to remove or service rotor installations. The guard rails should be designed to facilitate hosing or scraping of the ditch sidewalls.

E. Rotating Biological Discs

1. Applicability

The rotating biological contactor process may be utilized where wastewater is amenable to biological treatment.

2. Primary Treatment Requirements

The minimum acceptable primary treatment prior to the rotating contactor process shall be: screening, grit removal, and primary clarification equipped with scum and grease collecting devices. Bar screening and/or comminution are not suitable as the sole means of pretreatment.

3. Housing

As a minimum, all rotating biological contactors shall be provided with a cover or be placed within an adequate enclosed structure. Covers and structures shall be constructed of suitable corrosion-resistant material. Concrete buildings will not be approved. Design of buildings should consider condensation reduction measures, such as insulation and/or heating.

4. Access

In general, access to each shaft shall be provided so that it may be safely removed utilizing equipment reasonably available to the owner. Covers shall be designed so that access to shafts and shaft bearings and shaft removal will not be impaired. Buildings shall be equipped with doors of sufficient size to permit entrance of necessary maintenance vehicles and removal of shafts.

5. Sizing Criteria

Design standards, operating data and experience for this process are not well established. Project submittals considering the use of this type of system shall include the latest design information available. In determining unit sizing, the following parameters should be considered:

- a. Design flow rate and primary effluent waste strength.
- b. Percentage of BOD_5 to be removed.
- c. Media arrangement, including number of stages and unit area in each stage.
- d. Rotational velocity of the media.

- e. Retention time within the tank containing the media.
- f. Wastewater temperature.
- g. Percentage of influent BOD_5 to the process which is soluble.

6. Final Sedimentation Tanks

The requirements of Section F of this chapter shall apply.

F. Final or Secondary Sedimentation Tanks

1. General

Final or secondary sedimentation tanks are utilized after a biological treatment process to remove and concentrate suspended solids. The solids may be returned to the process or disposed of via sludge handling facilities.

2. Inlets, Sludge Collection and Sludge Withdrawal Facilities

Inlets, sludge collection and sludge withdrawal facilities shall be so designed as to minimize density currents and assure rapid return of sludge to the aeration tanks.

3. Number of Units

Multiple tanks capable of independent operation are desirable and shall be provided for all installations serving a design population equal to or greater than 10,000 P.E.

4. Scum Removal

Effective baffling and scum removal equipment shall be provided for all final settling tanks.

5. Surface Skimming

Surface skimming capabilities shall be provided for all final or secondary tanks.

6. Depth

The minimum sidewater depth for final settling tanks shall not be less than 10 feet.

7. Capacity

Since the rate of recirculation of return sludge from the final settling tanks to the aeration or reaeration tanks is quite high in the activated sludge processes, the detention time, surface overflow rate and weir overflow rate should be adjusted for the various processes to minimize problems with sludge loadings, density currents, inlet hydraulic turbulence, and occasional poor sludge settleability. The following minimum design parameters should be observed. (See Figure II.)

FIGURE II
SUMMARY TABLE OF SECONDARY/FINAL CLARIFICATION
FOR BIOLOGICAL TREATMENT PROCESSES

Type of Process	Average Design Flow, MGd	Minimum Detention Time hrs. Based On Average Design Flow	Surface Overflow Rates* gal/day/sq.ft.		Weir Overflow Rate gal/day/ft.	
			Based on Average Design Flow**		Not to Exceed	
Trickling Filter Bio-Disc	to 0.5	3.0	600		5,000	
	0.5 to 1.5	2.5	700		10,000	
	1.5 up	2.0	800		15,000	
Conventional Activated Sludge	to 0.5	3.0	600		5,000	
	0.5 to 1.5	2.5	700		10,000	
	1.5 up	2.0	800		15,000	
Step Aeration Activated Sludge	to 0.5	3.0	600		5,000	
	0.5 to 1.5	2.5	700		10,000	
	1.5 up	2.0	800		15,000	
Contact Stabilization Activated Sludge	to 0.5	3.5	600		5,000	
	0.5 to 1.5	3.0	700		10,000	
	1.5 up	2.5	800		15,000	
Extended Aeration Activated Sludge	to 0.5	3.0	600		5,000	
	0.5 to 1.5	2.5	700		8,000	
	1.5 up	2.0	800		12,000	
Complete Mix Activated Sludge	to 0.5	3.0	600		5,000	
	0.5 to 1.5	2.5	700		10,000	
	1.5 up	2.0	800		15,000	

Solids Loading

Solids loadings shall not exceed 1.25 lbs. per square foot per hour or 25.0 lbs. per square foot per day. In systems which are designed to operate at high mixed liquor suspended solids (4000 mg/l and higher) settleability tests must be conducted to determine settling basin sizing.

* Consideration will be given to higher overflow rates for clarifiers of proven superior efficiency in diameter larger than 50 feet.

** If the design peak 24-hour flow is greater than twice the design average 24-hour flow, the following shall apply (based on the design peak 24-hour flow): Surface Overflow Rates - 1200 gal/day/sq. ft. for Trickling Filters and Bio-Discs; 1400 gal/day/sq. ft. for all other processes; Weir Overflow Rates - 30,000 gal/day/ft. for all processes. Larger values for both average and peak conditions may be utilized on a case-by-case basis where justification is presented by the design engineer.

8. Return and Waste Sludge Equipment (Following Activated Sludge Facilities)

a. Return Sludge Rate

The minimum permissible sludge return rate from the final settling tank is a function of the concentration of suspended solids of the incoming mixed liquor, the sludge volume index of these solids, and the length of time the solids are retained in the settling tank. Since undue retention of solids in the final settling tanks may be deleterious to both the aeration and sedimentation phases of the activated sludge process, the rate of sludge return should generally be variable. The maximum rate of sludge return capability expressed as a percentage of the average design wastewater flow shall, as a minimum, be in the range of 75 to 100 percent. The rate of sludge shall be varied by means of variable speed motors, drives, or timers (small plants) attached to the sludge pumps.

Devices shall be installed for indicating flow rates of wastewater primary effluent and return sludge to each tank unit. For plants designed for wastewater flows of 1.0 MGD or more, these devices should totalize and record as well as indicate flows. Where the design provides for all return sludge to be mixed with the raw wastewater (or primary effluent) at one location, then the mixed liquor flow rate to each aeration unit should be measured.

b. Return Sludge Pumps

If motor driven return sludge pumps are used, the maximum return sludge capacity shall be obtained with the largest pump out of service. A positive head should be provided on pump suction. Pumps should have at least 4-inch suction and discharge openings.

If air lifts are used for returning sludge from each settling tank hopper, no standby unit will be required provided the design of the air lift is such as to facilitate their rapid and easy cleaning and provided other suitable standby measures are furnished. Air lifts should be at least 3 inches in diameter.

c. Return Sludge Piping

Suction and discharge piping should be at least 4 inches in diameter and should be designed to maintain a velocity of not less than 2 feet per second when return sludge facilities are operating at normal return sludge rates. Suitable devices for observing, sampling and controlling return activated sludge flow from each settling tank shall be provided.

d. Waste Sludge Facilities

Waste sludge facilities shall be provided for all activated sludge units. Drying beds and a liquid sludge loading apparatus shall be provided as a minimum. Deviations will be approved only on a case by case basis.

Waste sludge control facilities should have a maximum capacity of not less than 10% of the average rate of wastewater flow and should function satisfactorily at rates of 0.5% of average flow or a minimum of 10 gallons per minute, whichever is larger. Means for observing, measuring, sampling, and controlling waste activated sludge flow shall be provided. Waste sludge may be discharged to primary settling tanks, concentration or thickening tanks, sludge digestion tanks, vacuum filters, sludge loading facilities or any practical combination of these units.

X. WASTE STABILIZATION PONDS

A. General

Waste stabilization ponds can be defined as shallow man-made basins utilizing natural processes under partially controlled conditions for the reduction of organic matter and the destruction of pathogenic organisms in wastewaters.

Waste stabilization ponds can be divided into the following three types:

- a. Anaerobic Pretreatment Unit - includes ponds in which the whole liquid content is anaerobic.
- b. Aerobic or Facultative Pond - includes ponds in which the majority of the liquid content is aerobic. May be discharging or non-overflowing.
- c. Aerated Ponds - includes ponds which are artificially aerated by surface or subsurface aeration devices.

Waste stabilization ponds are considered adequate treatment only when they are designed to produce the quality of effluent as is required by the Water Pollution Control Section, Bureau of Water Quality. Anaerobic ponds used for treating raw wastewater must be followed by multiple cell aerobic ponds.

1. Facilities Plan

When ponds are selected as the design recommendation, the facilities plan and design plans and specifications shall include the information required in the chapter entitled "Soils". For non-overflowing ponds, information must be presented in the facilities plan demonstrating the relationship between inflow, precipitation, evaporation and seepage for both winter and summer conditions. Ideally, the ponds should gain liquid depth slightly in winter and lose an equal amount in summer at design operational levels.

2. Location

a. Distance from Habitation

A waste stabilization pond site should be as far as practicable from habitation or any area which may be built up within a reasonable time period. The minimum distance from existing habitations, served habitations, and property lines for waste stabilization ponds is included in the chapter entitled "General Design Considerations".

b. Prevailing Winds

If practicable, waste stabilization ponds should be located so that the local prevailing winds will be toward uninhabited areas. Preference should be given to sites which will

permit an unobstructed wind sweep across the ponds, but care should be taken to prevent excessive erosion resulting from wave action.

c. Surface Runoff

Location of ponds in watersheds receiving significant amounts of runoff water is not permitted unless adequate provisions are made to divert stormwater around the pond and protect all embankments.

d. Groundwater Pollution

Proximity of ponds to water supplies and other facilities subject to contamination and location in areas of porous soils and/or fissured rock formations should be critically evaluated to avoid creation of health hazards or other undesirable conditions.

A minimum of 10 feet between the bottom of a waste stabilization pond and the average annual elevation of the groundwater table shall be provided. Where such separation cannot be provided, an artificial liner conforming to ASTM D3083 and 30 mills in thickness or a 1 1/2 foot clay blanket shall be utilized. The clay blanket shall be tested and compacted as required in the chapter entitled "Soils". Test results shall be submitted verifying that the resultant water loss through the layer is essentially zero.

3. Basis of Design

- a. The maximum organic loads, minimum detention times, and operational depths for waste stabilization ponds shall be as indicated in the table on the following page.

B. Anaerobic Ponds

1. Anaerobic ponds shall not be utilized for municipal water pollution control facilities. Normally, anaerobic ponds are utilized for industrial wastes such as meat packing wastes. The suitability of anaerobic ponds for a particular application will be considered only on a case-by-case basis. Anaerobic ponds must be followed by aerobic wastewater treatment facilities. Care must be taken in the design of the aerobic wastewater treatment facilities so as to adequately treat the ammonia portion of the waste so that excessive ammonia will not be discharged to the stream.
2. Water loss through embankments and bottoms of anaerobic ponds must be less than 1/8 inch day. A clay liner of at least two feet or an impermeable membrane is desirable. Construction may be of reinforced concrete or a suitable man-made material. An artificial liner of materials other than concrete must be at least 30 mills in thickness and conform to ASTM D 3083. The artificial liner must be impervious to grease and oils, and be resistant to deterioration by sunlight.

Waste Stabilization Ponds
Adopted 8-17-78

Type of Pond	Pounds BOD ₅ /1000 ft ³	Pounds BOD ₅ /Acre Total Surface Area At Operational Level	Detention Time in Days	Operational Water Depth in Feet
Anaerobic	15 to 30	--	5 and Up	10 to 20
Non-Overflowing	--	Up to 34	Infinite	Up to 5
Continuously Discharging	--	Up to 34 for the primary and secondary cells only	120 above the bottom level (all cells)	Up to 5 (5 to 10 for final cells)
Controlled Discharge	--	Up to 34 for the primary and secondary cells (No allowance shall be given for the holding cells).	120 above the 2 foot level (all cells)	Up to 5 (primary cells) 5-8 (holding cells)
Aerobic with Arti- ficial Aeration				
Facultative	Up to 0.5	--	5 to 20	5 to 12
Mixed (low rates)				
Complete Mixed (high rate).	Up to 30	--	1 to 5	10 to 12

3. A minimum of two anaerobic ponds shall be provided to be operated either in series or parallel.
4. The inlet to an anaerobic pond shall be in the lower one-third of the depth. The inlet line must be easily cleaned and preferably situated so that bottom sediments cannot plug the inlet line.
5. The outlet structure must be baffled so that surface scum will not carry over. The outlet device must be designed to facilitate easy cleaning.
6. Special care must be taken to locate the facility as far as possible from all residences, commercial developments and work areas. If possible, the prevailing wind should be away from inhabited areas.
7. Inner side slopes should be $2\frac{1}{2}:1$. Outer slopes should be $3\frac{1}{2}:1$.

C. Aerobic or Faculative Waste Stabilization Ponds

Aerobic or faculative waste stabilization ponds may be (a) nonoverflowing or evaporative, (b) controlled discharge, or (c) discharging.

1. Non-Overflowing or Evaporative Type Ponds

A non-overflowing or evaporative type pond is dependent upon evaporation and limited water loss through embankments and bottoms to maintain a non-overflowing condition. As a consequence, the hydraulic consideration not the organic loadings, will control the design the majority of the time. Non-overflowing designs are usually desirable in the western one-half of the state if sufficient land is available.

a. Number of Cells

A minimum of two cells must be provided. The cell area should be designed so that 60% of the surface area is allocated to the primary portion and the remaining area to the secondary cell. The design engineer may wish to provide multiple cells, but the basic proportional split (60% primary, 40% secondary) should remain unchanged. If large increases in contributing population are anticipated during the design period, the addition of a third cell should be considered.

b. Land Application (Irrigation) of Excess Wastewater

In order to maintain a facility in a non-overflowing category, irrigation may be utilized. Irrigation is not recommended for facilities with less than a 500 P.E. design. Land application of effluents is covered in more detail in the chapter entitled "Land Application of Wastewater Effluent or Sludge".

2. Discharging Waste Stabilization Ponds

Discharging waste stabilization ponds depend upon lengthy detention times to stabilize the wastewater. The ponds may discharge continuously but must be designed to produce the quality of effluent that is required by the Water Pollution Control Section, Bureau of Water Quality.

a. Design Basis

Discharging lagoons may be designed on the following basis:

- i. Three Cells; two treatment cells based on 34 lbs./BOD₅/ Acre/Day (at the 5 foot level), with a 60-40% split between the primary and secondary cell.
- ii. The third cell may be 8-10 feet deep.
- iii. Effluent baffling must be provided and/or multiple draw off points utilized, to reduce algal release.
- iv. Total storage (bottom to operational levels) must be at least 120 days, based on average design flow with no losses.
- v. The treatment cells should be piped for series and parallel operation. The third cell should be piped to operate in series only with Cells 1 and 2, Cell 1, or Cell 2. Introduction of raw wastewater into Cell 3 is prohibited.
- vi. This design will not require the use of algal reduction measures other than those listed above. Federal grant applications for new lagoons and for those upgrading projects that are justified for reasons in addition to suspended solids may use this design procedure.

b. Controlled Discharge of Waste Stabilization Ponds

A controlled discharge waste stabilization pond is designed on an organic basis similar to continuously discharging ponds, but a minimum of two holding cells shall also be utilized following the primary cells.

A minimum of two treatment cells shall be designed on an organic basis as required for continuously discharging waste stabilization ponds. A minimum of two holding cells shall be designed into the system so that the entire facility (including all cells) shall have a minimum storage of 120 days above the two (2) foot level. Each holding cell must have a minimum storage of 14 days above the two (2) foot level and may be up to eight (8) feet deep.

Effluent drawoff locations, elevations and baffling shall be designed so as to minimize solids discharged in the effluent.

D. Aerated Ponds

There are two types of artificially aerated ponds, facultative and complete mix. For the purposes of this document, facultative aerated ponds are defined as those ponds with sufficient mixing to provide uniform oxygen dispersion throughout the pond without maintaining all solids in suspension. In this mode, some deposition of solids and some anaerobic processes will occur at the pond bottom. Complete mix ponds will be defined for the purposes of this document as those having adequate mixing to maintain all solids in suspension and provide uniform oxygen dispersion.

The design criteria for artificially aerated ponds will be as follows:

1. Facultative

Cell No. 1 - aerated cell, cell volume based on 70% BOD₅ removal under winter operating conditions, water depths up to 12 feet, aeration to be based on oxygen demand and oxygen dispersion. A minimum of 6 horsepower per million gallons will be required for mixing.

Cell No. 2 - aerated or unaerated cell. Aerated cell - sizing of cell to be based on remaining BOD₅ to be removed (5 days minimum), water depths to 12 feet, aeration to be based on oxygen demand and dispersion. Unaerated cell - sizing of cell to be based on a maximum surface loading of 34 lbs. BOD₅/acre/day, water depths to 5 feet.

Cell No. 3 - unaerated cell, cell volume based on 3 to 5 days maximum detention at average design flows, water depths to 12 feet, and a minimum of three effluent draw-off levels to be provided. A minimum water depth of 8 feet will be required.

2. Complete Mix

Cell No. 1 - aerated cell, cell volume based on 1 to 3 days aeration at average design flows, water depths up to 12 feet, aeration to be based on oxygen demand (may be developed from complete mix activated sludge equations without recirculation), and mixing requirements. A minimum of 60 horsepower per million gallons will be required for mixing.

Cell No. 2 - aerated cell - sizing of cell to be based on remaining BOD₅ to be removed (5 days minimum), water depths to 12 feet, aeration to be based on oxygen demand and dispersion.

Cell No. 3 - unaerated cell, cell volume based on 3 to 5 days detention at average design flows, water depths to 12 feet, and a minimum of three effluent draw-off levels to be provided. A minimum water depth of eight feet will be required.

3. General

- a. Flexibility - the systems must be designed to operate normally in series. However, flexible piping for emergency operation conditions will be required. Systems utilizing flow recirculation will be considered on a case-by-case basis.
- b. Slope Protection - See Section E.2.e. of this chapter
- c. Aeration Equipment Placement - aeration equipment in primary cells must be installed near influent lines to maximize mixing of and oxygen transfer to the incoming wastewater.
- d. Conversion of Existing Pond Systems - Modifications to existing systems will in general conform to the requirements for new systems as discussed above. Minimum and maximum detention times will generally be as required for new systems, and three cells will be required. Minimum required depths for the third cell will not apply.
- e. Flow Measurement - As a minimum, a weir installation for both the influent and effluent must be provided for aerated ponds.
- f. Separation Distances - Facultative mix ponds will be subject to the same requirements as aerobic ponds. Complete mix ponds will be subject to the same requirements as activated sludge facilities.
- g. Standby Equipment - Aeration equipment shall be provided in duplicate with each aerator equal to the total aeration requirement; or if two aerators are utilized to supply total aeration requirements, a third aerator shall be supplied as standby equipment with an aeration capacity equal to one-half the total aeration requirement.

E. Pond Construction Details

1. Flexibility

All waste stabilization ponds should be designed to maximize operator flexibility. The operator should be able to discharge raw sewage to all primary cells and be able to remove cells from service for routine maintenance or emergency repair.

Gravity drains for cells in the system will not be approved unless gravity drainage is to another cell in the system.

2. Embankments

a. Excavation and Compaction

For excavation and compaction requirements, see the Chapter entitled "Soils".

b. Top Width

The minimum embankment top width should be 8 feet to permit access of maintenance vehicles, except for lagoons with a capacity of less than 25 population equivalent, where a minimum of 5 feet may be provided.

c. Slopes

Embankment slopes should be 3:1 or $3\frac{1}{2}$:1 horizontal to vertical. Deviations, either steeper or flatter, must be fully justified prior to initial design.

d. Freeboard

Minimum freeboard shall be 3 feet except for ponds with a capacity of less than 25 population equivalent, where a minimum of 2 feet may be provided.

e. Erosion Protection

Erosion protection for all waste stabilization pond structures, regardless of size, shall be considered. Erosion protection via the use of concrete or asphaltic aprons, baffles, stone rip-rap, or artificial membranes shall be utilized on pond cells of 3.0 acres or larger such that the windward embankment slopes affected by the prevailing wind(s) will be protected. Consideration should be given to the Southwesterly and Northwesterly wind directions in most instances.

Aerated pond cells shall have slope protection on all embankments if the treatment concept is designed on a complete mix basis. If the aerated pond is designed on a facultative basis, slope protection will be provided for all windward slopes of prevailing wind(s) and may be required on the remainder of the embankments depending upon the size and characteristics of the aeration equipment.

Proper soil sterilization techniques should be utilized with the construction of any erosion protection devices. The entire area under the erosion protection materials must be sterilized regardless of the material used.

Stone rip-rap should not be smaller than two inches in diameter nor larger than five inches in diameter.

Placement of rip-rap or other erosion protection devices should be such that quiescent areas, conducive to mosquito breeding, are not formed.

f. Vegetation Control

The application of an approved type of soil sterilant shall be specified which when used in compliance with the manu-

facturer's recommendations will prevent vegetation growth over the bottom of the pond and up to the maximum water line on the embankments.

g. Seeding

Embankments shall be seeded from the outside to the maximum water line on the embankments. Perennial type short rooted, low growing, spreading grasses which withstand erosion and can be kept mowed are most satisfactory for seeding of embankments. Recommended varieties are: Brome, Fescue, Rye, Blue Grass and Buffalo Grass. All other disturbed areas other than those areas sterilized as required above should also be seeded.

3. Shape

The shape of all cells shall be such that there are no narrow or elongated portions. Round, square, or rectangular ponds with a length not exceeding three times the width are considered most desirable. No islands or coves shall be permitted. Embankments should be rounded at corners to minimize accumulations of floating materials and to facilitate grass mowing.

4. Influent Lines

a. Material

Any generally accepted material for underground sewer construction with mechanical or solvent welded joints shall be used for the influent lines to the pond. The material selected should be adapted to local conditions.

b. Location

Influent lines shall be located along the bottom of the pond and secured to the bottom of the pond so that the flow line is near the average elevation of the pond bottom. This line can be placed at zero grade. Surcharging of the sewer upstream from the inlet manhole is not permitted. A minimum of 6 inches between the bottom elevation of the inlet structure and the maximum operational water level in the lagoon must be provided.

c. Point of Discharge

The influent line should be situated to maximize the horizontal distance from the inlet to the outlet. In the design of non-overflowing waste stabilization ponds, the inlet lines should terminate in the approximate center of the pond.

d. Discharge Apron

The end of the discharge line shall be secured to a suitable concrete apron. The minimum size of this apron shall be 2 feet square.

5. Overflow Structures, Interconnecting Piping & Draining of Ponds

a. Material

Any generally accepted material for underground sewer construction with mechanical or solvent welded joints shall be utilized for interconnecting piping and effluent lines.

b. Overflow Structure

Overflow structures should consist of a manhole or a concrete box equipped with multiple-valved drawoff lines or an adjustable overflow device so that the liquid level in the pond can be adjusted. The lowest of the drawoff lines to such structures should be located at least 6 inches off the pond bottom to avoid pickup of deposits and prevent erosion. Overflow from the pond during ice-free periods should be taken near, but below, the water surface to withdraw the best effluent and insure retention of floating solids. Scum baffles are recommended to improve effluent quality.

c. Interconnecting Piping

Interconnecting piping for multiple unit installations operated in series should be valved or provided with other arrangements to regulate flow between structures and permit flexible depth control. The interconnecting pipes should discharge horizontally near the pond bottom to minimize the need for erosion control measures and should be terminated as near the dividing dike as construction permits. The piping shall allow the system to be operated in parallel or series operation. Interconnecting piping shall be supported and be provided with splash blocks.

6. Rock Filters

Rock Filters are utilized as a method of total suspended solids control in waste stabilization pond effluents. They are acceptable for use in conjunction with non-aerated ponds and non-aerated ponds used as followup cells for aerated pond systems.

The filter material shall be loaded no greater than 3 gal./day/ft³.

Filter rock shall be a uniform size from 3-5 inches in diameter with the following gradation limits:

<u>Sieve Size (in.)</u>	<u>% Passing</u>
5	100
4	90-100
3	40-50
2 1/2	0-2

The filter shall extend a minimum of 1 foot above the water surface. The effluent collection pipe must be so constructed as to minimize plugging. The filter material should be placed in a manner to circumvent damage to effluent collection lines. The material used for the filter media should be resistant to freeze-thaw cycles.

7. Miscellaneous

a. Fencing

The pond area shall be adequately fenced to provide for public safety, to prevent trespassing, and to prevent livestock entrance. A vehicle access gate of sufficient width to accomodate mowing equipment should be provided. The gates should be provided with locks. Waste stabilization ponds should have at least a 4 foot, hog-tight, woven wire fence (minimum 36 inches with two strands of barbed wire to 48 inches).

b. Warning Signs

Appropriate signs shall be provided along the fence around the pond to designate the nature of the facility and advise against trespassing. A minimum of one sign shall be provided on each side of the fenced area.

c. Flow Measurement

See the chapter entitled "General Design Considerations".

d. Depth Measurement

A device permanently installed to allow easy observation of pond operational depths for all cells for all types of ponds is required. The use of a calibrated mast, pipe, or inclined concrete section of the dike may be used. If a calibrated mast or pipe is utilized, the mast or pipe shall be adequately anchored. Wooden staff gauges will not be approved. The outlet structure may also be utilized if properly and permanently calibrated.

XI. SLUDGE DIGESTION AND PROCESSING

A. Anaerobic Sludge Digestion

1. The anaerobic digestion process is utilized in wastewater treatment to reduce the sludge volume and volatile content and to provide stabilization. The process is efficient and demands little operational expense. This section contains information relative to single stage digestion, two stage digestion and high rate digestion.
2. Anaerobic digestion units are designed on the basis of organic loading per cubic feet of digestion capacity. Whenever possible, the design information should be obtained from chemical analysis and measurement of the type and volume of wastewater and/or sludge to be treated. If this design approach is not feasible, the following estimates may be utilized for design purposes:

Type of Sludge	lbs./capita/day (Dry Weight Solids)
Primary Sludge	0.12
Standard Rate Trickling Filter Sludge	0.05
High Rate Trickling Filter Sludge	0.07
Waste Activated Sludge	0.08
Combination of Primary & Secondary Sludges	0.17 - 0.20

These generalized factors are based on the assumption that (a) the digestion process will be heated and maintained in the temperature range of 85-96° (29-25.5°C), (b) the percentage of volatile solids will be assumed to be 0.70 (70%) of the dry weight solids, (c) digested sludge will be removed at regular intervals, (d) the digester will be reasonably well mixed, and (e) the sludge is principally domestic with no significant industrial contributors.

3. Design Criteria

- a. Where the character and volume of the wastewater and the resultant sludges is known, the total digestion tank loadings and calculations should be determined by rational calculations based upon such factors as: volume of sludge to be treated, total solids concentration, volatile solids concentration, temperature, mixing, desired volatile solids reduction, further treatment and/or disposal of digested sludge, and further treatment and/or disposal of supernatant liquors. Appropriate calculations and references should be submitted to justify the basis for design. The following information is presented to serve as guidelines for the anaerobic digestion process.

Sludge Digestion and Processing
Adopted 8-17-78

Parameter	Standard Rate	High Rate (Mixing Required)
Solids Retention Time (SRT), days	30 to 60	10 to 20
Solids Loading, lb. VSS/1000 cu. ft/day	40 to 100	100 to 400
Volume Criteria, cu. ft/capita		
Primary Sludge	2 to 3	1-1/3 to 2
Primary Sludge + Trickling Filter Sludge	4 to 5	2-2/3 to 3-1/3
Primary Sludge + Waste Activated Sludge	4 to 6	2-2/3 to 4
Combined Primary + Waste Biological		
Sludge Feed Concentration, percent solids (dry weight basis)	2 to 4	4 to 6
Digester Underflow Concentration, percent solids (dry weight basis)	4 to 6	4 to 6

As noted, the high rate process requires considerably less detention time and volume, and operates successfully with a higher solids loading when compared to the standard rate (conventional) process. This is attributed to the greater use of the digestion tank for biological activity and improved mixing.

b. Limited Mixed and Heated Systems

For digestion systems providing limited mixing through sludge recirculation only, the system may be loaded up to 100 pounds of volatile solids per 1000 cubic feet of volume per day in the active digestion units. The minimum sludge retention time shall be 30 days for limited mixed and heated systems.

c. Effectively Mixed and Heated Systems

For digestion systems providing effective mixing (in a form other than sludge recirculation), the system may be loaded up to 400 pounds of volatile solids per 1000 cubic feet of volume per day in the active digestion units. The minimum sludge retention time shall be 10 days for effectively mixed and heated systems.

4. Design Details

a. Safety

Non-sparking tools, rubber soled shoes, safety harness, gas detectors for inflammable and toxic gases, and gas masks of the oxygen type shall be provided.

b. Multiple Units

Multiple tanks capable of independent operation are recommended and shall be provided for all installations serving a design population equal to or greater than 10,000 P.E. Where a single digestion tank is used, a storage tank for emergency use shall be provided so the digestion tank may be taken out of service without unduly interrupting plant operation.

Where multiple units are provided, each unit should be designed to serve as either a primary or secondary digestion tank. The primary digester is the active biological reactor. The secondary digester provides sedimentation for the concentration of the digested sludge and formation of a relatively clear liquor zone for supernatant drawoff. Combination of several digestion units shall provide a minimum of three days detention period in the secondary or sedimentation units.

c. Depth

The proportion of depth to diameter should provide for a minimum of six feet storage depth for supernatant liquor.

d. Slope

The tank bottom should slope to drain toward the sludge withdrawal pipe. For tanks equipped with sludge scraping mechanisms, minimum bottom slopes of 1 vertical to 12 horizontal should be provided. A bottom slope of 3 to 12 should be provided for tanks without sludge scraping mechanisms.

e. Sludge Inlets and Outlets

Two or more sludge inlets and withdrawal ports and a minimum of two recirculation suction and discharge points shall be provided unless adequate mixing facilities are located within the digester. One inlet should discharge above the liquid level and be located at approximately the center of the tank to assist in scum break-up. Raw sludge inlet discharge points should be located to minimize short-circuiting to supernatant withdrawal points.

f. Digestion Tank Heating

1. All anaerobic digestion systems must be heated through the use of external sludge heating methods. Piping shall be designed to allow preheating of feed sludge prior to the introduction into the digester tank. The heating system should be capable of allowing a temperature of at least 90°F (32°C) to be maintained at all times. This capacity is in addition to all other heating requirements.

2. Mixing Valves

A suitable mixing valve shall be provided to temper the boiler water with heat exchanger bath so that the inlet water to the heat exchanger can be held to a temperature of 140°F (60°C) or less. Manual control should also be provided by suitable bypass valves where automatic valves are installed.

3. Boiler Controls

The boiler shall be provided with suitable automatic controls to maintain the boiler temperature at 180°F (82°C) or more, to minimize corrosion, and to shut off the main gas supply in the event of pilot burner or electrical failure, low water level or excessive temperatures.

4. Thermometers

Thermometers shall be provided to indicate temperatures of the sludge in the digester, sludge feed, sludge return, hot water return, and boiler water.

g. Mixing

1. Effective mixing of the anaerobic digester may be provided by means of mechanical mixing equipment. Alternative proposals will be considered.
2. Certification of mixing capacity through field testing prior to owner acceptance should be provided. The certification must indicate pumpage rates and the actual measured tank turnover time.
3. Each digestion tank with mixing capability shall have sufficient mixing equipment or flexibility to insure that the total capability for mixing is not lost with the loss of any one piece of mixing equipment. The provision for uninstalled standby mixing equipment on site will be permitted.

h. Access Manholes

1. At least two (2) access manholes, thirty (30) inches in diameter or larger, should be provided in the top of each digestion tank in addition to the gas dome. One access manhole should be located over the supernatant withdrawal piping.
2. At least one access manhole, large enough to permit the use of mechanical grit removal equipment, should be installed in the sidewall of each digestion tank.
3. All access manholes shall be provided with gas tight and watertight covers.

5. Gas Collection, Piping and Appurtenances

a. General

All portions of the gas system including the space above the digestion supernatant, the storage facilities, and the piping shall be designed so the gas will be maintained under pressure under all normal conditions, including sludge withdrawal. All enclosed areas where gas leakage might occur shall be adequately ventilated.

b. Safety Equipment

Pressure and vacuum relief valves, flame traps, and automatic safety shut-off valves are essential components in the gas collection system. Water seal equipment shall not be installed.

c. Gas Piping and Condensate

Gas piping should be sized for three to four times the average gas production rate and in no case shall be less than 2 1/2 inches in diameter and shall slope to condensation traps at low points. A minimum of 2 percent slope shall be provided. The maximum velocity in sludge gas piping should not be more than 12 fps. The use of float controlled condensate traps is not permitted. All gas lines should be kept above ground and color coded.

d. Gas Utilization Equipment

Gas burning boilers, engines, or other sludge gas utilization equipment should be located at ground level, and provided with continuous forced ventilation rooms. Gas lines to these units shall be provided with suitable flame traps.

e. Meter

A gas meter with bypass should be provided to meter total gas production.

f. Waste Gas

Waste gas burners shall be readily accessible and should be located at a safe distance from buildings. Gas lines for wasting gas shall be provided with flame traps.

g. Electrical Fixtures

Electrical fixtures in enclosed places where gas may accumulate shall comply with the National Board of Fire Underwriters specifications for hazardous conditions.

h. Ventilation

Any underground enclosure connecting digestion tanks or containing sludge or gas piping or equipment shall be provided with continuous forced ventilation. Tight fitting self-closing doors should be provided at connecting passageways and tunnels to minimize the spread of gas.

6. Supernatant Piping

a. Supernatant piping will have a minimum diameter of six (6) inches.

b. The supernatant must either be returned to the treatment process or to a suitable alternative treatment process. Any alternative treatment process shall be presented in detail.

c. Supernatant piping should be arranged so that withdrawal can be made from three (3) or more levels.

d. A positive unvented and unvalved overflow shall be provided.

B. Aerobic Sludge Digestion

1. Single and Multiple Tanks

Multiple tanks shall be provided at plants having a capacity equal to or greater than 10,000 P.E.

2. Mixing

Effective mixing of the aerobic digester can be provided by both mechanical aeration or diffused aeration equipment. A minimum of 15 minutes turnover time for the entire digestion tank contents of sludge must be provided. Certification of mixing capacity by field testing before the owner accepts the system shall also be provided.

The aeration equipment, including the air diffusion piping and diffuser system, shall be similar to those used in the activated sludge process.

3. Size and Number of Tanks

The size and number of aerobic sludge digestion tanks should be determined by rational calculations based upon such factors as size of the plant, volume of sludge added per day, percent of solids in raw sludge, percent reduction of volatile solids required, and the volume of sludge storage provided. Aerobic sludge digesters should be sized to provide a minimum of 10 days sludge retention time at 20°C. The production of stabilized sludge is the primary concern in determining the volume needed in sludge digestion.

Unless calculations are submitted to justify the design, the following minimum design parameters shall govern:

- a. The minimum capacity of the aerobic digestion tank shall be 3.0 cubic feet per capita served.
- b. The minimum volume of air supplied should not be less than 20 CFM (at STP) per thousand cubic feet of digester liquid volume.
- c. The aeration system shall be capable of transferring a minimum of 3 mg/l oxygen per hour to each 1000 mg/l VSS concentration in the digestion liquid.
- d. Tank configuration and depth shall be similar to those used in the complete mix activated sludge process.

4. Supernatant Withdrawal

Supernatant should be withdrawn from a point approximately 6 inches beneath the liquid surface of the digester after a minimum of 1 but not more than 3 hours quiescent settling period. Multiple supernatant withdrawal points are encouraged.

Further treatment for the withdrawn supernatant shall be provided either by returning to the head of the plant or to a point prior to the final clarifier.

5. Sampling Facilities

A sludge sampling valve of the quick-closing type should be installed not more than one foot from the bottom of the aeration tank. The valve and piping should be at least 1 1/2 inches in diameter.

6. Maintenance Provisions

The tank bottom should slope to drain toward the sludge withdrawal pipe. The minimum slope shall be 3 vertical to 12 horizontal.

C. Sludge Pumps and Piping

1. Sludge Pumps

a. Capacity

Pump capacities shall be adequate to pump the maximum amount of sludge being produced in the appropriate treatment unit with the following minimum concentrations:

Primary sludge 4%; combined primary and trickling filter sludge 3%; combined primary and waste activated sludge 3%; standard rate trickling filter sludge 3%; waste activated sludge 1%; anaerobically digested sludge 10%; and aerobically digested sludge 2%.

Provisions for varying the sludge pumping capacity are required. This may be accomplished by the use of constant flow pumps with a time clock or with the use of variable capacity pumps. Variable capacity pumps not pumping waste activated sludge should have a variation in pump capacity of ± 50 percent. Pumps provided only for pumping waste activated sludge should have a varying capacity as required in section F. of the chapter entitled "Mechanical Biological Treatment".

b. Duplicate Units

Duplicate units shall be provided unless adequate justification is provided.

c. Type

Positive displacement pumps, screw feed pumps or other types of pumps with demonstrated solids handling capability should be provided for handling primary sludge. Centrifugal or air-lift pumps may be used for handling sludge from secondary processes.

d. Sampling Facilities

Unless sludge sampling facilities are otherwise provided, quick closing sampling valves shall be installed at the sludge pumps. The diameter of sampling valves and piping shall be at least 1 1/2 inches.

2. Sludge Piping

a. Size and Head

Sludge withdrawal piping should have a minimum diameter of 6 inches for gravity withdrawal and for pump suction. Sludge pump discharge piping should be at least 4 inches in diameter. Airlift pump discharge lines should be at least 3 inches in diameter. The head available for withdrawal of sludge shall be at least 4 feet if removal is dependent upon gravity flow.

b. Slope

Gravity piping should be laid on uniform grade and alignment. Slope on gravity discharge piping should not be less than 3 percent. Valves and connectors should be provided so all discharge lines can be drained and flushed.

c. Supports

Piping and pipe supports located inside the digestion tank should be fabricated from corrosion resistant material. Heavy duty pipe supports are required.

D. Sludge Dewatering

1. Sludge Drying Beds

a. Area

The climatic conditions, character and volume of the sludge to be dewatered shall be used to determine the area needed for sludge drying beds. Unless calculations are submitted to justify the design, the minimum size bed for digested sludge shall be not less than 1 square foot per capita for percolation type and 1 1/2 square feet per capita for impervious type beds. Smaller areas may be used if alternative methods of sludge dewatering are provided.

b. Percolation Type

Underdrains: Underdrains should be clay pipe, plastic, or concrete drain tile at least 4 inches in diameter. Underdrains should either be laid with open joints spaced not more than 20 feet apart, or should be perforated pipe. The underdrain system must be capable of withstanding loadings imposed by mechanical sludge removal equipment.

Gravel: Gravel around the underdrains should be properly graded and should be a minimum of 12 inches in depth. At least 6 inches of gravel should extend above the top of the underdrains. It is desirable to place the gravel in two or

more layers. The top layer, of at least 3 inches depth, should consist of gravel 1/8 to 1/4 inch in size. The bottom layer should consist of gravel 3/4 to 1 1/2 inches in size.

Sand: The top layer should consist of at least 6 inches of clean, coarse sand. Greater depths are recommended. The sand shall have an effective size ranging from 0.5 to 0.8 mm and a uniformity coefficient of less than 5. The finished sand surface should be level.

c. Walls

Walls should be water-tight and extend 15 to 18 inches above the sand surface and at least 6 inches below the ground or paved surface. Outer walls should be curbed to prevent soil from washing into the beds.

d. Sludge Removal

Not less than two beds shall be provided and they should be arranged to facilitate sludge removal. Truck supports should be provided for all percolation type sludge beds which do not have mechanical sludge removal devices. These supports should be constructed of concrete slabs at least 3 feet wide and 6 inches thick. Pairs of supports should be located on 20 foot centers.

e. Sludge Influent

The sludge pipe to the beds shall terminate at least 12 inches above the bed surface and should be arranged so that it will drain. Concrete splash plates for percolation type beds should be provided at sludge discharging points.

f. Cover

Consideration should be given to provide cover for drying beds where climatic conditions are not favorable for the use of open beds. A minimum covered bed area of 1 square foot per capita shall be provided.

E. Digested Sludge Ponds

Ponds for the storage of digested sludges during inclement weather may be utilized. Sludge ponds shall not be substituted for adequate sludge digestion and shall not be approved for use as a sludge volume reduction process. Sludge lagoons shall not be utilized for final disposal of sludges. Piping of sludge lines to sludge ponds shall be arranged so that the ponds will be bypassed during normal sludge wasting operations. Where feasible, sludge piping shall be arranged so that undigested sludges cannot be transferred to the pond. The pond(s) shall be designed to facilitate cleaning.

The "General" and "Pond Construction Details" sections of the chapter entitled "Waste Stabilization Ponds" shall in general apply to sludge ponds. Where possible, sludge ponds should not be located near developed areas.

F. Mechanical Dewatering Facilities

1. Design and Operation

The design and operation of mechanical dewatering facilities shall be conducted in accordance with the manufacturer's recommendations under his warranty certificate.

2. Capacity

The minimum capacity for mechanical dewatering facilities should be provided so that in no case will more than 20 hours operation per day occur at design loads, unless alternative methods of sludge disposal are provided.

3. Duplicate Units

Duplicate units or alternative means for disposal of the sludge shall be provided.

4. Sludge Storage Tanks

Sludge storage preceding the mechanical dewatering facility shall have a minimum capacity of 24 hours sludge production where undigested sludge is dewatered.

5. Meters

Means for measuring the quantity of sludge processed should be provided.

G. Drainage and Filtrate Disposal

Drainage from beds or filtrate from dewatering units should be returned to the sewage treatment process at appropriate points unless separate additional treatment and/or disposal is provided. Where disinfection is required, the filtrate shall be returned to a point preceding disinfection.

H. Final Disposal of Sludge (see chapter entitled "Land Application of Wastewater or Sludge")

1. Hauling the Liquid Sludge

In the case of transporting sludge without dewatering to the ultimate disposal site, a paved and drained loading pad, sludge crane and tank truck shall be provided.

2. Sludge Storage

Sludge storage requirements are included in the chapter entitled "Land Application of Wastewater Effluent or Sludge".

3. Sludge Disposal

Digested sludge in liquid form can be disposed of on agricultural land. Undigested liquid sludge shall not be disposed of without receiving additional treatment.

a. Sludge Disposal on Agricultural Land

See chapter entitled "Agricultural Application of Wastewater or Sludge"

b. Sludge Disposal on Sanitary Landfill

Digested sludge can also be spread on solid waste layers in sanitary landfills, provided that the sludge layers will be covered daily. The maximum amount of sludge being disposed of on a sanitary landfill is decided by the absorption capacity of the solid wastes, but in no case shall result in ponding on the top of solid waste layers. Dewatering processes shall be provided to treat all sludges prior to disposal by landfill.

I. Incineration

Both digested and undigested sludge following proper dewatering may be incinerated. Provision for suitable residue disposal and proper air pollution control devices shall be made:

1. Design and Operation

The design and operation of incineration shall be conducted in accordance with the manufacturer's recommendation under his warranty certificate.

2. Capacity

Sufficient capacity for incinerators shall be provided to incinerate the maximum amount of sludge which could be produced by the sludge dewatering facilities unless alternative methods of dewatered sludge disposal are provided.

3. Duplicate Units

Duplicate units, or alternative means for dewatered sludge disposal shall be provided.

4. Scales

Means for weighing the quantity of sludge cake being incinerated and the residue produced shall be provided.

XII. DISINFECTION

A. Purpose

The primary purpose of disinfection is to destroy pathogenic microorganisms prior to discharge of an effluent to a receiving stream or lake where the discharge of these microorganisms would interfere with the intended use of the stream or lake.

B. Where Required

1. The use of disinfection for discharging wastewater treatment facilities will be reviewed on a case-by-case water quality basis.
2. Disinfection of wastewater effluent applied to the land will be used when required in accordance with the Bureau of Water Quality Policy Memorandum No. 3-78.

C. Methods of Disinfection

1. Chlorination is the most commonly used form of disinfection; therefore, the minimum design criteria and considerations presented will address only the design of chlorination facilities.
2. Consideration will be given to ozonation and other methods of disinfection where their use can be justified by the design engineer.

D. Deviations

1. Deviations from these minimum design criteria will be reviewed on a case-by-case basis when accompanied by adequate justification.

E. Chlorination Facilities and Equipment

1. Design Calculations

- a. All design assumptions and calculations used in sizing the chlorination facilities must be included in the facilities plan. These will include as a minimum:
 - (1) Diurnal peak flows which would cause fluctuations in effluent chlorine demand and residual(s) if applicable.
 - (2) Total quantity of chlorine required daily at the present and design flows.
 - (3) Dosage required to effectively complete disinfection. Design should be for a maximum total chlorine residual in the effluent not to exceed 0.5 mg/l as Cl.
 - (4) Detention time of the chlorine contact chamber at the minimum and maximum hourly flow for both the present loads and the design loads.
 - (5) pH and temperature of the influent to the chlorine contact chamber.

2. Chlorine Supply

a. Recommended sizes of gas cylinders

- (1) The maximum withdrawal rate for 100 and 150 pound cylinders should be limited to 40 pounds per day per cylinder.
- (2) The maximum withdrawal rate for 2,000 pound cylinders should be limited to 400 pounds per day per cylinder.

b. Minimum handling equipment required for 100 and 150 pound cylinders

- (1) A hand truck specifically designed for cylinders.
- (2) Restraints for securing cylinders to prevent them from falling over.

c. Minimum handling equipment for 2,000 pound cylinders

- (1) Hoist with two-ton capacity.
- (2) Cylinder lifting bar.
- (3) Monorail or hoist with sufficient lifting height to pass one cylinder over another.
- (4) Cylinder trunnions to allow rotating the cylinders for proper connection.
- (5) Equipment combining scales for cylinder weighing and the hoist is recommended.

d. Manifolds

- (1) The connection of containers discharging liquid chlorine to a manifold should not be utilized. The difference in pressure which could occur due to temperature or non-condensable gases, or due to difference in elevation head, will cause chlorine to flow to the container at the lower pressure. The container could become full of the liquid and, if the container valve were closed, hydrostatic pressure could cause rupture.
- (2) The connection of containers discharging gaseous chlorine may be utilized; however, all containers should be at the same temperature to prevent transfer of gas from a warm container to a cool container unless the system is designed to permit it.

3. Chlorine Contact Chamber

a. Configuration

- (1) To reduce short-circuiting to a minimum, the chlorine contact basin should have a serpentine configuration with longitudinal baffling. The length-to-width ratio should be designed at 40:1 as a minimum (the total length of the channel created by the baffles should be 40 times the distance between the baffles).

b. Chlorine contact time

- (1) The chlorine contact chamber should provide a minimum detention time of 30 minutes at the average daily design flow or fifteen minutes at the maximum hourly flow, whichever chamber volume is greater.

c. Provisions for access and cleaning

- (1) Access to the chlorine contact chamber presents a hazard due to the corrosive atmosphere; therefore, cast iron steps should not be used. Aluminum ladders with hooks at the top are preferred.
- (2) To permit ease in cleaning, provisions shall be made to return the chlorine contact chamber contents to a raw sewage inlet. This may be accomplished through the use of a sump, drain, or portable pumping unit. The chamber or unit shall not be pumped or drained to the outfall line. Baffles in the chamber should be utilized to prevent the discharge of floating material.
- (3) Flexibility in piping and baffling must be provided so that each section of the chamber may be drained for cleaning without affecting the adequate use of the rest of the chamber. This will permit continuous disinfection in a section of the chamber while the other sections are being cleaned.

4. Diffusers

- a. Diffusers should be designed to accomplish immediate mixing.
- b. The diffuser should be located in the pipe or channel in such a manner so as to maximize the distribution of the chlorine or gas solution. On larger diameter pipes it is desirable to utilize multiple diffusers to maximize the distribution. Open channel type diffusers should be placed in an area of maximum turbulence with a minimum water cover of nine inches and should be constructed for easy removal.
- c. The minimum recommended velocity through the diffuser openings is 10-12 fps.

5. Mixing

- a. Mixing of the chlorine solution and wastewater should occur instantaneously and prior to the contact chamber. Mixing should not be attempted in the contact chamber due to the short-circuiting and inefficient disinfection that can result.
- b. The use of a hydraulic jump is preferred for achieving rapid mixing in an open channel.

- c. Mechanical mixers should be located in a mixing chamber immediately downstream from the point of chlorine injection. The mixing chamber should be designed as small as possible.
- d. It is recommended that larger installations utilize mechanical mixers in conjunction with diffusers to maximize the immediate distribution of the chlorine solution.
- e. Injection of the chlorine solution into a full flowing pipe as the sole means of dispersing the chlorine solution into the wastewater is the least efficient means of mixing and is not recommended.

6. Piping

- a. Piping used in the conveyance of chlorine should minimize the number of joints used. It should also be protected against temperature extremes and be well supported.
- b. Piping designed for use with dry chlorine gas should be constructed with copper, iron, or steel, and should be protected from the entrance of air or water.
- c. Piping designed for use with aqueous solutions of chlorine should be constructed with hard rubber, sara-line, rubber-lined, polyethylene, polyvinylchloride, or Uscolite materials for protection from corrosion.
- d. All valves used should be Chlorine Institute approved.

7. Chlorine Equipment Housing

- a. Chlorine equipment that is housed in a building used for other purposes shall be isolated from the rest of the building by a gas-tight partition. It should be located at or above ground, and near the point of application to minimize the length of chlorine lines.
- b. The door to the chlorinator room shall swing open only to the outside and shall be equipped with panic hardware. The room should be constructed with no apertures common to the other rooms which would permit chlorine gas to enter other work areas.
- c. The storage area for the chlorine cylinders should be separated from the room housing the chlorine feeders and equipment.
- d. A clear glass, gas-tight inspection window shall be constructed on an interior wall of the chlorinator room to allow chlorine feeders and equipment to be viewed without entering the room.
- e. Sufficient space should be allotted to the equipment room to permit easy access to all equipment for maintenance, repair and expansion.

- f. A forced air exhaust ventilator is required for all chlorine feeder equipment rooms. The vent shall be located near the floor and shall discharge at an outside location which will not contaminate the air inlet to any buildings. The outside end of the vent should bend down to prevent water from entering and should be covered with a screen to exclude insects. The ventilation equipment should be designed to provide a complete air change at least every two minutes. Where continuous ventilation is provided, the ventilation equipment should be designed to provide a complete air change at least 6 times per hour. Alternative ventilation schemes may be utilized in larger facilities.
- g. An air inlet ventilator should be installed near the opposite side of the room from the exhaust ventilator.
- h. The electrical controls for the room shall be designed in such a manner that the lights and ventilators will operate automatically when the door is opened. They must also be capable of being manually operated from the outside without the door being opened.
- i. The chlorine equipment and storage rooms shall be provided with a means of maintaining a temperature of at least 65°F. They shall also be protected from temperature extremes. Gas cylinders should not be stored near outside windows.
- j. It is recommended that facilities with a capacity less than 1.0 mgd provide chlorine feed-rate control proportional to the flow. It is also recommended that facilities with a capacity greater than 1.0 mgd provide a feedback control circuit that is tied into automatic chlorine residual monitoring, i.e., closed loop control.
- k. Weighing scales of corrosion resistant materials should be provided to determine the amount of chlorine supply remaining. For facilities which utilize only one gas cylinder at a time, it is recommended that the cylinder being used and the standby cylinder be installed on scales that are read separately.
- l. An adequate supply of water shall be provided for operating the chlorinator. When potable water is used to operate the injectors, provisions should be made to avoid cross-connections. If a booster pump is to be used, duplicate equipment must be provided.
- m. For large facilities, an alarm system must be provided to alert the operator of leaks or other malfunctions in the chlorine supply, chlorine metering equipment or chlorine residual equipment.
- n. OSHA - approved gas masks must be provided for each installation. They should be kept in a cabinet outside the chlorination room near the entrance to the room but not close

enough that they could be made inaccessible by chlorine fumes from a leak. Self-contained oxygen supplying masks shall be provided for repairing leaks. Canister type masks may be used for changing cylinders but are not adequate for sustained use in an atmosphere containing chlorine gas. The instructions for using, testing, and replacing mask parts must be displayed on the cabinet door.

- o. An emergency patching and repair kit similar to those designed by the Chlorine Institute should be provided and stored where they will not be made inaccessible by a chlorine leak.

F. Reliability

Standby chlorination equipment will be required on a case-by-case basis.

G. Dechlorination

- 1. Dechlorination of chlorinated effluents may be required if the discharge of such effluents may be detrimental to the preservation of the aquatic biota in the receiving stream.

H. Operation and Maintenance

- 1. The following, as a minimum, should be addressed in the Operation and Maintenance Manual:
 - a. Operation and maintenance for all apparatus utilized, including safety devices.
 - b. Unloading, transferring, and hookup procedures for containers.
 - c. Leak detection and repair. Detailed instructions for the use of the emergency patching and repair kit should be included. The operator should be trained thoroughly in the use of these kits.
 - d. First aid
 - e. Spills
 - f. Externally-caused emergencies, i.e., fires, power failures, flooding, etc.
 - g. Effects of overdoses on receiving streams.

XIII. AGRICULTURAL APPLICATION OF WASTEWATER OR SLUDGE

Introduction

The majority of land application systems in Kansas can be designed to utilize sludges or wastewaters for improved crop production and not strictly for waste disposal. The development of the entire system requires expert evaluation of many interrelated variables. Professional advice by environmental and agricultural engineers as well as agronomists and other scientists is essential to the design of a well conceived land application system.

The intent of this section is to present design requirements for land application systems and also provide guidance for the preparation of a detailed engineering report. As a minimum, the land application of wastewater must be preceded by primary treatment. Additional treatment requirements depend upon the nature of the application sites. This is presented in more detail in Table 13, located in the appendix. The criteria in this chapter specifically applies to the application of domestic waste. Depending on the composition of some industrial or agricultural wastes, and the specific land application site, different requirements may be necessary. This decision will be made on an individual basis.

Wastewater land application systems are classified by the Water Pollution Control Section, Bureau of Water Quality, as follows (see Table 13):

1. Treatment oriented, (no direct point discharge to waters of the State): where irrigation of wastewater effluent is an integral component of the overall treatment process and is employed to eliminate point source discharges to waters of the State.
2. Irrigation oriented, (periodic point discharges to waters of the State): where treated effluent is utilized as needed for supplemental water and where the treatment system can meet NPDES effluent limitations for discharge to waters of the State.

A short preliminary report shall be submitted to this office before extensive investigation of any land application of wastewater. The report will allow this office to determine the scope of engineering work necessary for the project. It is anticipated that for many small systems much of the detailed investigations as outlined in the following sections can be eliminated. Items that should be included in the preliminary report are:

1. The nature of irrigation proposed (i.e., as supplemental water for crops or as a treatment process to prevent discharge from the wastewater treatment plant.)
2. Present treatment, if any, and the condition of the wastewater treatment plant.
3. Volume of wastewater to be irrigated.

Agricultural Application of Wastewater or Sludge
Adopted 8-17-78

4. Proposed land application site(s) (contour map showing houses, wells and drainage courses in the affected area).
5. Estimated groundwater depth and flooding potential.
6. Soil type and permeability.
7. The intended use of the irrigated land.
8. The anticipated water management scheme.
9. Location of the wastewater storage structure.
10. Significant industrial contributors.

This report will enable the Water Pollution Control Section, Bureau of Water Quality to determine the extent of irrigation and the potential hazards. It will also provide the information necessary to classify the project.

Minimum Design Requirements

The design of land application systems for wastewater effluents and sludges is highly dependent upon management. All parameters and assumptions used are to be justified.

A. Site Considerations

1. A separation distance of 500 feet shall be provided between residential areas and the outside perimeter of the land area used for application of wastewater effluents and sludges. For exceptions, see Table 13.
2. A minimum of 200 feet shall separate the perimeter of the land application area from wells or water supplies not located upon the property. Adequate protection must be provided for wells and water supplies situated upon the site. For exceptions, see Table 13.
3. When adequate conservation measures are not provided, the topography of the site shall be less than 5%. Where subsurface drainage is poor, maximum slopes will be based on soil type.
4. The groundwater and any perched water shall be at a depth of at least 10 feet beneath the land application area. Reductions of this separation requirement will be considered where soil conditions are not conducive to percolation of applied materials.
5. The land application area shall not be subject to flooding more frequently than once in 10 years, while the treatment and storage system must be protected as required for treatment facilities in the chapter entitled "General Design Considerations for Sewage Treatment Works".

Agricultural Application of Wastewater or Sludge
Adopted 8-17-78

6. A minimum 100-foot buffer zone should normally be established adjacent to the perimeter of the land application site to provide separation from adjacent properties. Greater separation distances should be considered where sprinkler equipment is used, while less separation is needed when techniques with lower potential for dispersing materials, such as subsurface injection of sludge, are used. For exceptions, see Table 13.
7. Crops used for human consumption in the raw state shall not be produced upon the land application site. Generally, crop production should be restricted to feed grains and forages which can be utilized by the livestock industry.

B. Storage and Application of Wastewater Sludges

1. Storage shall be provided for a minimum of 60 days average sludge production where equipment is available for operation under adverse conditions. Where special application equipment is not available, additional storage capacity will be required.
2. Sludge handling and application equipment shall be capable of transporting and applying 30 day average sludge production accumulations within a 5 day period.
3. Normally, sludge application rates should not exceed 20 tons of dry solids per acre per year. A lower rate may be required where soil conditions, heavy metal content, or crop nitrogen requirements warrant.
4. A soil pH greater than 6.5 must be maintained at the site to reduce the solubility and plant uptake of heavy metals.

C. Application of Wastewater Effluent for Treatment and Irrigation Oriented Systems

1. Pumping equipment shall be capable of handling solids 1 to 2 inches in diameter. Conventional centrifugal and turbine pumps used by the irrigation industry are normally acceptable.
2. Sprinkler irrigations systems shall be designed so application rates do not exceed the soil infiltration rate.
3. The wastewater effluent application system shall be capable of restricting the application rate to 3 acre-inches per day per acre.
4. The annual application of wastewater effluents shall not exceed 40 acre-inches/acre. Normally, the annual application rate is determined by soil and crop moisture and/or nutrient requirements.
5. All flood or partial flood irrigation systems shall provide tailwater control provisions or facilities. When employed, tailwater pits must be capable of retaining 20% of the daily wastewater quantity applied. Pump back or direct land application provisions shall be made to dewater the tailwater pit. Sprinkler

Agricultural Application of Wastewater or Sludge
Adopted 8-17-78

irrigation systems not using tailwater control facilities must be capable of containing the applied wastewater through proper management. For exceptions, see Table 13.

6. All pumping and wastewater effluent application equipment shall be designed to prevent damage from freezing weather.
- D. Storage and Application of Wastewater Effluent for Treatment Oriented Systems Only
1. Wastewater effluent storage shall be provided to retain a minimum of 90 days average dry weather flow. Following adequate secondary treatment, the maximum water depth in the storage cell shall be 15 feet. Following primary treatment, the maximum water depth in the first storage cell shall be 5 feet and any additional cells may be as deep as 15 feet.
 2. Dewatering and land application equipment shall be capable of applying the 90 days storage quantity within a 30 day period.
 3. Normally, a minimum of 2 pumps shall be provided per land application system for operational flexibility and reliability.
 4. Selection of pumping and application equipment shall be based upon 12 hours operation per day.

Engineering Report

A. Evaluation of Wastewater and Sludge Characteristics

1. General

A preliminary design step is the detailed evaluation of the present influent wastewater quantities and characteristics. If high influent heavy metals concentrations or toxic substances are found, control measures will be required. An analysis of the present and estimates of future effluent and sludge quantities and characteristics will be necessary. In addition to the items listed in the composition analysis, other substances may have to be analyzed when they are found to have a potentially harmful effect upon the environment.

2. Typical Quantities

a. Effluent

In the case of waste stabilization ponds, infiltration, percolation and evaporation can significantly reduce the quantity of effluent available for land application. It is recommended that direct field measurements be made to evaluate these losses. A detailed water balance will be required.

b. Sludge

While sludge quantities are generally more predictable than effluents, Table 6 in the appendix illustrates the striking

increase in the volume of sludges to be processed when a plant is upgraded to activated sludge treatment. Therefore, the analysis should be made for the individual plant under consideration.

3. Composition

a. Effluent

The effluent composition analysis should include total dissolved solids, suspended solids, pH, BOD₅, total nitrogen, nitrate nitrogen, ammonia nitrogen, total phosphorous, total potassium, alkalinity as CaCO₃, SAR, copper, cadmium. In special instances, an analysis may be required for the following elements: selenium, cobalt, chromium, arsenic, boron, iron, aluminum, mercury, silver, barium, sulfur, calcium, magnesium, sodium, inorganic carbon and organic carbon. Average values for different treatment processes are given for the above items in Tables 1 and 2 in the appendix.

b. Sludge

The sludge composition analysis should include: pH, total nitrogen, ammonia nitrogen, nitrate nitrogen, total phosphorous, total potassium, percent dry and volatile solids, copper, nickel, lead, zinc, and cadmium. As in the effluent composition, an analysis may be required for the following elements in sludge: selenium, cobalt, chromium, arsenic, boron, magnesium, sodium, inorganic carbon and organic carbon. Tables 7, 8, and 9 in the appendix provide information on the composition of various municipal sludges.

B. Site Considerations

1. Site Location

Preferably, the site selected for land application should be located near the treatment and storage facility yet remote from places of habitation. A detailed topographic map of the area will be necessary for site selection and the subsequent system design. Of primary concern are the effects of storm runoff and erosion both from adjacent land onto the site and from the site onto adjacent lands or into surface waters. The description of the site location should include both the distance and elevation difference from the treatment plant to the disposal area. Any significant obstructions to sludge or effluent transmission such as rivers, freeways, or developed residential areas should be identified.

2. Relationship to Land Use Plans

Of significant importance in site selection is the compatibility of the disposal system with regional land use plans within at

Agricultural Application of Wastewater or Sludge
Adopted 8-17-78

least two miles of the land application area. Adjacent land use and proximity to areas developed for residential, commercial or recreational activities should be ascertained.

3. Surface Water and Wells

The relationship of surface water to the overall hydrology of the area requires evaluation. All wells in the area should be located on a topographic map of the land application site.

4. Climate

Rainfall data requires evaluation with respect to quantities, durations, and seasonal distribution. Temperature analysis should include the maximum periods of freezing conditions during which the ground is frozen. This is of special interest in determining sludge and effluent storage requirements.

5. Flooding Potential

Corps of Engineers and historical data must be reviewed to determine the possibility of flooding on the site and adjacent area.

6. Soil Profile and Characteristics

Soil characteristics are most important when evaluating the system. Desirable soil properties for effluent and sludge assimilation are: good percolation capacity, fine enough texture to have high water and nutrient holding capacity, good drainability and aeration and neutral or alkaline pH. A soil profile will be required for the selected site. Generally, the profile should be determined to a minimum of 10 feet.

7. Permeability Characteristics

The permeability of the land application site should be determined for the prevalent soil textures. Permeability is a function of cropping practice, water quality, permeability of deeper soil layers, antecedent moisture and soil texture. It is recommended that county agents, agronomists, Soil Conservation Service personnel and others having knowledge of the specific site be consulted.

8. Groundwater Depth

The depth to groundwater along with any seasonal variations will be required. Sites should be investigated both for existing and potential perched water tables.

9. Contractual Agreement

Contractual agreements are required for the use of land or facilities not owned or directly controlled. The agreement must consider the availability of land and equipment for long term

Agricultural Application of Wastewater or Sludge
Adopted 8-17-78

utilization by the municipality or industry concerned with the disposal of its sludge or effluent.

10. Monitoring

Groundwater monitoring may be required. The Water Pollution Control Section, Bureau of Water Quality will make this determination on an individual basis. When necessary, the groundwater quality should be monitored immediately below the water table surface. Pollutational materials entering the groundwater system have a tendency to remain in the upper few feet. Before actual effluent or sludge application begins, groundwater quality data must be obtained. The samples must be analyzed for the following:

- a. Chloride
- b. Specific Conductance
- c. pH
- d. Total Hardness
- e. Alkalinity
- f. Ammonia Nitrogen, Nitrate Nitrogen, Nitrite Nitrogen
- g. Total Phosphorous
- h. Any heavy metals or toxic substances found in the applied wastes.
- i. COD

11. Environmental Assessment

The impact of the project on the environment must be assessed for each land application alternative. When evaluating the overall environmental impact, special consideration should be given to those effects that relate directly to public health. These effects include:

- a. Groundwater quality
- b. Increase of insects and rodents
- c. Runoff from the site
- d. Odors
- e. Contamination

The overall effects of the proposed system should be evaluated in light of their impact on the sociological aspects of the community. Included in the evaluation should be considerations of: relocation of residents, effects on recreational activities, community growth, and the quality of life.

C. Wastewater Effluent Land Application Considerations

The majority of the land effluent application systems within Kansas can be designed to deliver and provide supplemental water and nutrients for improved crop productivity. Crop selection and wastewater application rates cannot be considered independently of the site selection or design approach. Consideration must be given to the climate and hydraulic capabilities of the soil and terrain. The system should be capable of maintaining or improving soil structure, crop production and maximize the utilization of moisture and nutrients.

Agricultural Application of Wastewater or Sludge
Adopted 8-17-78

1. Annual Application Rates and Crop Selection

The ability of crops and soils to assimilate wastewater effluents without adverse effects will generally determine the maximum annual application rates. Normally, the yearly application of wastewater will be determined by the moisture and nutrient requirements of the selected cropping practice. In some instances, soil structure and/or wastewater characteristics will limit annual application rates. Effluent application rates are not to exceed 40 inches/acre/year.

a. Nutrients

The primary nutrients requiring evaluation are nitrogen and phosphorous. Nitrogen is readily available to plants in the form of nitrate, nitrite, and ammonium. Excessive applications should be avoided because nitrogen in the nitrate form is soluble and mobile in water, stable in groundwater and presents a potential concern to human and animal health. As much as one-third of the organic nitrogen applied through wastewater may be released (mineralized) as ammonium and nitrified to nitrate the first year. The remainder will be retained (immobilized) in residual humus which continues to decompose and release mineral forms of nitrogen and other nutrients at reduced rates in subsequent years.

In general, annual application of nitrogen should not exceed 50% of its anticipated harvest removal at the expected yields. Where groundwater conditions are adequately monitored, higher nitrogen application rates may be utilized. The potential for harvesting nutrients is usually greater for perennials than annuals since a greater part of the growing season is used for nutrient uptake. Table 11 in the appendix indicates the nutrient uptake of various crops.

Nutrients which are not removed from the site by harvest of vegetation or plant products will tend to accumulate in the system. If not controlled, nitrogen and phosphorous retained in a standing crop and the residual on the site can present potential future sources of soluble nitrates and phosphates. The effective life of the land application system can be extended by removing some of the nitrogen and phosphorus through harvested crops.

b. Micronutrients

Micronutrients and heavy metals are generally expected to accumulate more in wastewater sludge rather than effluents. Micronutrient and heavy metal imbalance will be determined mainly by soil pH. Increased uptake is more likely under acidic conditions and may be minimized if soil pH is maintained between 6.5 and 8.0. Low concentrations of iron, manganese, or zinc may be beneficial to plants in some soils. Boron is soluble and its concentration should be limited to less than 1 mg/l for semi-tolerant crops. Increased uptake of cobalt, copper, molybdenum, or zinc in forage may benefit livestock.

Agricultural Application of Wastewater or Sludge
Adopted 8-17-78

c. Crop Moisture

Water provided by effluents is a natural resource readily utilized by crops and vegetation. The application of wastewater effluents should be conducted so as to minimize utilization of water for crops. Normally, wastewater should be applied during the winter months to replenish subsoil moisture or leach salt accumulations. Normally, an annual application of less than 40 inches/acre should be adequate to meet crop moisture demands.

The net annual irrigation requirements (water required in addition to rainfall) of crops varies from year to year depends upon rainfall, evapotranspiration rates, and antecedent subsoil moisture. For corn, net annual irrigation requirements range from 10-18 inches in Kansas, Table 3. The delivery efficiencies of most irrigation systems range from 60-75%. Therefore, annual application of wastewater required by corn is approximately 13-30 inches/year, depending on system location and efficiency.

d. Sodium and Salinity Hazard

When soils do not transmit rainfall and irrigation water rapidly enough to keep salts moving downward through the root zone and/or when wastewater containing more than 1250 mg/l dissolved solids (electrical conductivity of about 2.0 mmhos/cm) is applied regularly, salt injury may occur to sensitive crops. Wastewater with Sodium Adsorption Ratio

$$SAR = Na \frac{Ca + Mg}{2} - 1/2$$

values greater than 15 should not be applied to land due to potential adverse effects on soil structure and ultimate reduction in soil infiltration rates.

Proposed wastewater effluent land application systems should have a sodium and salinity hazard of medium or less. If the sodium or salinity hazard is severe, special water and soil management practices are necessary. Table 4 and Figures 1a, b, and c in the appendix are provided for general reference.

2. Land Application System Components

The system must not deliver application rates greater than the soil's capacity to accept water. The applied wastewater should not result in runoff or ponding upon the site. For example, instantaneous application rates for row crops should not exceed 0.5 inches/hour on clay loams. To avoid excessively rapid transit through the soil, the application rate should not exceed 1.5 to 2 inches in a 24 hour period.

Agricultural Application of Wastewater or Sludge
Adopted 8-17-78

The design of a wastewater effluent land application system is similar to the development of a surface water supply for irrigation. The main components of the system are: storage reservoir, delivery, and irrigation equipment.

a. Storage and Delivery

Storage provisions must be adequate to hold effluent accumulations during periods in which irrigation activities are not conducted. Anticipated increases in effluent quantities must be allowed for in the initial design. The type of treatment system, climatic characteristics, cropping practices, and land application restraints all influence the storage required. See Table 13.

Most wastewater treatment systems in Kansas considering land application designs are of the waste stabilization pond type. A monthly schedule estimating effluent flow rates, system losses, and irrigation demands will identify storage requirements.

Open channels or pressure pipe can be used to deliver effluent to the irrigation site. Normally, distance and topography will dictate the need for pumping and closed conduits. The delivery system must be compatible with irrigation facilities used for land application purposes.

b. Irrigation Equipment

Sprinkler irrigation is extensively used for wastewater application. The water normally infiltrates the soil at the point where it falls. The soil texture, structure, and vegetative cover largely dictates the maximum water intake rate (See Table 5). The type of sprinkler irrigation equipment will vary depending upon land area, labor availability, economics, and climatic factors. The three systems commonly utilized are: solid set, central pivot, and gaint or boom sprinkler.

Surface irrigation systems generally require some land shaping and leveling. Either a pipe or open channel can be used to convey and distribute water at the high end of the field. The system requires a collection, storage, and handling system to control excess water at the low end of the field. Furrow irrigation systems are used for row crops and provide good surface drainage for handling runoff from heavy precipitation. Another advantage of furrow irrigation systems is that wastewater does not contact plant foliage and vegetation.

D. Considerations for Land Application of Sludges

1. Annual Application Rates

a. Crop Nitrogen Requirements

If the sludge has a low metal content and the soil has slight limitations as defined in Table 12, then it is possible to use it as a nitrogen fertilizer to optimize crop growth. However, it may be necessary to use commercial fertilizer to furnish required potassium levels for maximum crop production.

After addition to soil, sewage sludge is slowly decomposed, resulting in the release of nitrogen available for plant growth. Current data suggests that 15-20% of the organic nitrogen is converted to plant-available forms the first year and that 3% of the remaining organic nitrogen is released each year for at least three subsequent years. Thus, plant available nitrogen is released for several years after sludge has been added to soils. For example, decomposition of a sludge containing 3% organic nitrogen applied at 10 tons/acre/year for 3 years will release 41 lb. of nitrogen the fourth year. Thus, sludge application rates will be limited by the quantity of readily available nitrogen in sludge (i.e., NH_4^+ and NO_3^-) and by the amount of nitrogen released during sludge decomposition in soil. Because of nitrogen losses from denitrification, ammonia volatilization, etc., nitrogen from sludge approximately equal to or 50% higher than the crop nitrogen requirement can be added to soils with minimal environmental risk. However, if sludge is incorporated immediately (e.g., injected), then available nitrogen from sludge must not be greater than the nitrogen requirement of the crop. Where groundwater conditions at the site are adequately monitored, the available nitrogen from sludge may be greater than the nitrogen requirement of the crop. Table 11 indicates the nitrogen utilization of several crops.

- b. Heavy metals are usually more of a limiting factor for land application with sludges than for effluents. If the sludge contains high concentrations of metals, then it should be used as a supplemental nitrogen source only and the application rates must be reduced accordingly. Of particular importance are the accumulations of cadmium, copper, molybdenum, nickel and zinc. The impact of these heavy metals, and others, on plants, animals and humans may be reduced by using rational management methods intelligently. When sludge is applied to land, special attention must be paid to good management of the site. For example, if the soil is allowed to become acidic, the solubility of a number of the heavy metals increases. This could result in their toxicity to plants and the unnecessary accumulation of some of these metals in the food chain. In addition, adequate management provisions must be taken to insure the protection of both ground and surface waters.

c. Soil Characteristics

Soil composition plays an important role in the ability of the land to assimilate waste products. Important factors for determination of application rates include: soil permeability, drainage, and moisture holding capacity. Where soils have moderate limitations, application rates should be restricted to less than 10 tons/acre/year of dry solids. When the soil conditions indicate slight restrictions, application rates of up to 20 tons/acre/year will be allowed. Application rates for larger facilities may be based on monitoring at the site, instead of the limitations described above. Table 12 in the appendix should be consulted for the definition of slight, moderate or severe. Under no circumstances will land application sites be approved where severe soil limitations exist.

2. Land Requirements

The total land area required includes allowance for treatment, buffer zones, sludge storage, sites for buildings, roads, ditches and land for emergency or future expansion.

3. Crop Selection

Crop selection must consider the amount of nitrogen utilized by a particular crop and its heavy metal uptake potential. Crops differ in their ability to absorb heavy metals such as cadmium from the soil. In many crops, the seeds contain lower concentrations of most heavy metals than do the vegetative tissues. Hence, the potential hazard from heavy metals is reduced if only the grain is harvested. In general terms, grain crops present a lesser heavy-metal hazard to the food supply than do forages, pastures, and leafy vegetables.

Agricultural Application of Wastewater or Sludge
Appendix

TABLE 1

AVERAGE EFFLUENT CHARACTERISTICS
FROM VARIOUS MUNICIPAL TREATMENT PLANTS¹

Constituent mg/l	TYPE OF PLANT			
	Primary	Trickling Filters	Activated Sludge	Ponds
Specific Conductivity umhos/cm	---	1,663	---	---
Total Dissolved Solids	1,402	1,166	917	1,330
pH, units	---	---	---	---
BOD	152	17	20	70
Total Nitrogen	37	16	23	23
Nitrate-Nitrogen	0.3	6.3	3.9	0.7
Ammonia-Nitrogen	23	5.9	17	8
Total Phosphorus	11	13	12.9	6.7
Chlorides	461	276	185	138
Sulfates	180	317	224	360
Alkalinity (CaCO ₃)	635	491	---	682
Boron	1.2	0.7	0.7	1.2
Sodium	329	267	192	257
Potassium	22	14	20	14
Calcium	96	80	52	92
Magnesium	34	50	37	48
Sodium Adsorption Ratio	7.5	5.6	5.0	5.2

Agricultural Application of Wastewater or Sludge
Appendix

TABLE 2

AVERAGE CONCENTRATIONS OF HEAVY METALS IN
MUNICIPAL WASTEWATER EFFLUENTS¹

<u>Constituent</u> <u>ug/l (ppb)</u>	<u>TYPE OF PLANT</u>			
	<u>Primary</u>	<u>Trickling</u> <u>Filters</u>	<u>Activated</u> <u>Sludge</u>	<u>Ponds</u>
Arsenic	2	3	8	6
Chromium	0	0	10	7
Copper	60	70	40	100
Lead	55	15	10	20
Manganese	35	10	10	30
Zinc	750	85	60	200
Iron	830	160	320	390

TABLE 3

NET YEARLY IRRIGATION REQUIREMENTS (INCHES)²
FOR RAINFALL 5 YEARS OUT OF 10

	<u>ALFALFA</u>	<u>CORN</u>	<u>SORGHUM</u>	<u>WHEAT</u>	<u>GRASS</u>	<u>SOYBEANS</u>
Colby	20.8	15.1	11.0	8.9	16.2	---
Garden City	22.5	16.0	11.9	10.4	22.5	---
Concordia	17.0	11.3	8.7	6.2	18.6	8.7
Hutchinson	19.1	11.8	8.8	7.3	19.6	9.1
Topeka	15.0	7.5	5.2	3.2	15.6	5.9
Columbus	11.6	7.5	5.5	---	14.1	6.0

The total annual irrigation requirement is dependent on system efficiency. The amount of water available to plants is approximately 50 to 85% of that supplies.

$$\text{Grass Irrigation Requirements} = \frac{\text{Net Irrigation Requirement}}{\text{Irrigation System Efficiency}}$$

SODIUM AND SALINITY HAZARD OF WATER USED FOR IRRIGATION FOR FIELD CROPS

Figures 1, 2, & 3³

SANDY SOILS

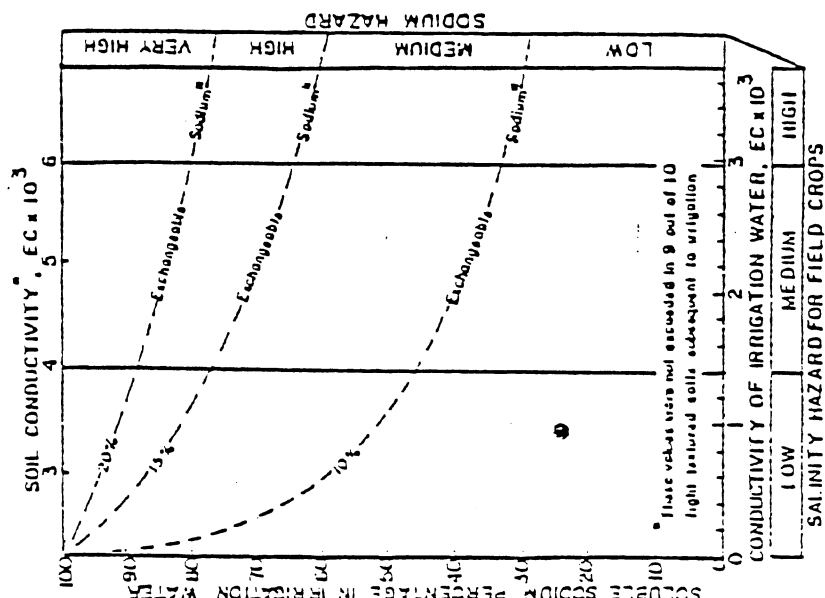


Figure 1. Salinity and sodium hazard classification of irrigation water for SANDY SOILS based on the conductivity and soluble sodium percentage in the water. The values given for soil conductivity (a measure of salt accumulation) and exchangeable sodium percentage in the soil are values not exceeded in 9 out of 10 cases subsequent to irrigation with a specific water.

LOAMY SOILS

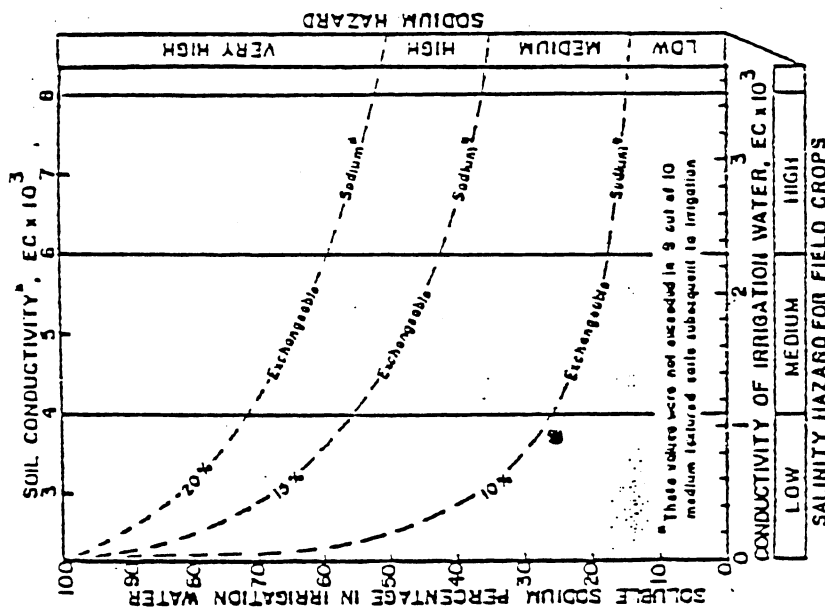


Figure 2. Salinity and sodium hazard classification of irrigation water for LOAMY SOILS based on the conductivity and soluble sodium percentage in the water. The values given for soil conductivity (a measure of salt accumulation) and exchangeable sodium percentage in the soil are values not exceeded in 9 out of 10 cases subsequent to irrigation with a specific water.

CLAYEY SOILS

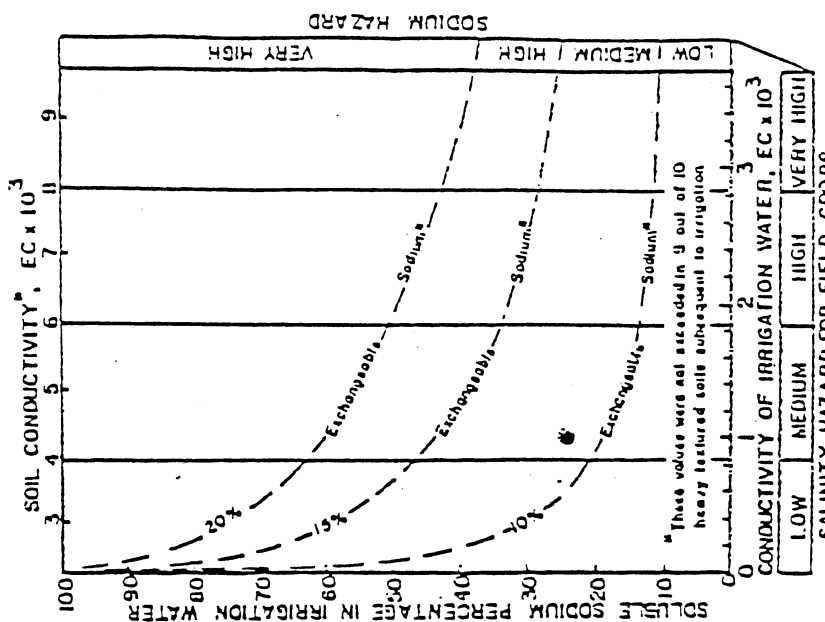


Figure 3. Salinity and sodium hazard classification of irrigation water for CLAYEY SOILS based on the conductivity and soluble sodium percentage in the water. The values given for soil conductivity (a measure of salt accumulation) and exchangeable sodium percentage in the soil are values not exceeded in 9 out of 10 cases subsequent to irrigation with a specific water.

Agricultural Application of Wastewater or Sludge
Appendix

TABLE 4

SALT TOLERANCE OF SELECTED FIELD³
AND FORAGE CROPS

CROP	ELECTRICAL CONDUCTIVITY* umhos/cm	SOIL SALINITY CLASSIFICATION
Bremuda Grass	13,000	Very High
Barley	12,000	
Tall Wheat Grass	11,000	
Sugar Beets	10,000	
Wheat	7,000	High
Tall Fescue	7,000	
Sorghum	6,000	
Soybean	5,500	Medium
Corn	5,000	
Alfalfa	3,000	Low
Orchard Grass	3,000	
Red Clover	2,000	

*Electrical conductivity of saturated soil extracts at which yields decrease by about 10 percent.

The electrical conductivity in well drained Kansas soils is normally less than three times the electrical conductivity of irrigation water.

TABLE 5
INFILTRATION RATES FOR VARIOUS SOIL TEXTURES⁴

<u>Soil</u>	<u>Infiltration Rates</u> <u>in/hr.</u>
Coarse Sand	0.5 to 1.0
Fine Sand	0.3 to 0.8
Sandy Loam	0.25 to 0.5
Silt Loam	0.25 to 0.4
Clay Loam	0.2 to 0.3
Clay	0.1 to 0.25

Infiltration or percolation rates are a function of time, cropping practice, quality of water, permeability of deeper soil layers, and antecedent moisture in addition to soil texture. The U.S.D.A. Soil Conservation Service has classified soil intake families for use in the design of irrigation systems. Selection of irrigation application rates increases with adequate cover and decreases with land slopes.

TABLE 6
TYPICAL SLUDGE VOLUMES PRODUCED⁵

<u>Wastewater</u> <u>Treatment Process</u>	<u>Gallons of Sludge Produced</u> <u>Million Gallons Wastewater Treated</u>			
Primary Sedimentation	2,950	3,530	2,440	3,000
Trickling Filter	745	530	750	700
Activated Sludge	19,400	14,600	18,700	19,400

TABLE 7
COMPOSITION OF REPRESENTATIVE ANAEROBIC SEWAGE SLUDGES⁴

<u>Component</u>	<u>Range*</u>	<u>Lb./Ton†</u>
Organic Nitrogen	1% - 5%	20 - 100
Ammonium Nitrogen	1% - 3%	20 - 60
Total Phosphorus	1.5% - 3%	30 - 60
Total Potassium	0.27% - 0.8%	4 - 16

*Percent of over-dry solids.

†Lb./Ton dry sludge.

TABLE 8

HEAVY METAL CONTENTS IN SLUDGE¹
(mg/l, Dry Basis)

Location	Zinc	Copper	Nickel	Cadmium
Dayton, Ohio	8,390	6,020	<200	830
Monterey, California	3,400	720	220	<220
Tahoe, California	1,700	1,150	<400	40
Millcreek, Cincinnati, Ohio	9,000	4,200	600	<40

TABLE 9

METALS IN SLUDGE¹
1971-1973

Element	Literature Geometric Mean (ppm)	Atomic Absorption Spread*	Geometric Mean (ppm)
Cd	61	5.89	93
Cu	906	2.66	1840
Hg	14.5	5.24	3.2
Ni	223	4.54	733
Pb	404	4.13	2400
Zn	2420	2.78	6380

*Spread is antilog of standard deviation of log-normal distribution.

Agricultural Application of Wastewater or Sludge
Appendix

TABLE 10

RELEASE OF RESIDUAL NITROGEN
DURING SLUDGE DECOMPOSITION IN SOIL

Years After Sludge Application	Organic N Content of Sludge, %						
	2.0	2.5	3.0	3.5	4.0	4.5	5.0
	lb. N Released per Ton Sludge Added						
1	1.0	1.2	1.4	1.7	1.9	2.2	2.4
2	0.9	1.2	1.4	1.8	1.8	2.1	2.3
3	0.0	1.1	1.3	1.7	1.7	2.0	2.2

TABLE 11

ANNUAL NITROGEN, PHOSPHORUS,
AND POTASSIUM UTILIZATION BY SELECTED CROPS

Crop	Yield	Nitrogen	Phosphorus	Potassium
		Lb. per Acre		
Corn	150 bu.	185	35	178
	180 bu.	240	44	199
Corn Silage	32 Tons	200	35	203
Soybeans	50 bu.	257†	21	100
	60 bu.	336†	29	120
Grain Sorghum	8,000 lb.	250	40	166
Wheat	60 bu.	125	22	91
	80 bu.	186	24	134
Oats	100 bu.	150	24	125
Barley	100 bu.	150	24	125
Alfalfa	8 tons	450†	35	398
Orchard Grass	6 tons	300	44	311
Brome Grass	5 tons	166	29	211
Tall Fescue	3.5 tons	135	29	154
Bluegrass	3 tons	200	24	149

*Values reported above are from reports by the Potash Institute of America and are for the total above-ground portion of the plants. Where only grain is removed from the field, a significant proportion of the nutrients is left in the residues. However, since most of these nutrients are temporarily tied up in the residues, they are not readily available for crop use. Therefore, for the purpose of estimating nutrient requirements for any particular crop year, complete crop removal can be assumed.

†Legumes get most of their nitrogen from the air, so additional nitrogen sources are not normally needed.

TABLE 12

SOIL LIMITATIONS FOR ACCEPTING
NONTOXIC BIODEGRADABLE SLUDGES AND SOLIDS¹

ITEM	<u>Degree of Soil Limitations</u>		
	SLIGHT	MODERATE	SEVERE
Permeability of the most restricting layer above 60 inches	Moderately rapid and moderate 0.6-6.0 in./hr.	Rapid and moderately slow 6-20 and 0.2-0.6 in./hr.	Very rapid, slow, and very slow >20 and <0.2 in./hr.
Soil Drainage	Well drained and moderately well drained.	Somewhat excessively drained and somewhat poorly drained.	Excessively drained, poorly drained, and very poorly drained.
Runoff	None, very slow, and slow.	Medium.	Rapid and very rapid.
Flooding	Soil not flooded during any part of the year.		Soil flooded during some part of the year.
Available water capacity from 0 to 60 inches or to a limiting layer water available to crop.	>7.8 inches	3-7.8 inches.	<3 inches sand.

TABLE 13

MINIMUM REQUIRED TREATMENT LEVEL.

<u>PROTECTED USE OF EFFLUENT</u>	<u>IRRIGATION ORIENTED (Periodic Discharge to Surface Waters)</u>	<u>SITE PROTECTION REQUIREMENTS</u>	
		<u>TREATMENT ORIENTED (No Discharge to Surface Waters)</u>	
Athletic fields, highway rest areas, or public parks with a high probability of body contact.	Secondary Treatment ¹ Filtration Disinfection	Secondary Treatment ¹ Filtration Disinfection ⁴ 90 Days Storage	Separation, buffer zone and tailwater control requirements deleted. Public use prohibited during irrigation and 8 hours thereafter.
Golf courses or public parks with a low probability of body contact.	Secondary Treatment ¹ Disinfection	Secondary Treatment ¹ Disinfection ⁴ 90 Days Storage	Separation, buffer zone and tailwater control requirements deleted. ²
Airfields, farmland, and other properties owned or leased by the municipality.	Secondary Treatment ¹	Primary Treatment ¹ 90 Days Storage ⁴	Irrigation to be conducted by employees of the permittee. Crops suitable for direct human consumption without process- ing shall not be irrigated. Tailwater control practices or provisions are to be provided. ³
Farmland and properties not owned or leased by the municipality.	Secondary Treatment ¹	Primary Treatment ¹ 90 Days Storage ⁴	Irrigation to be conducted by individu- al (s) under contract with municipality. Crops suitable for direct human consump- tion without processing shall not be irri- gated. Tailwater control practices or provisions are to be provided. ³

¹ Secondary treatment includes effluent from approved lagoon systems when withdrawn from the final cell above the two foot operational level.

² Use of treated effluent to cool golf greens during playing hours is prohibited. Consideration should be given to using a potable water connection to the golf course irrigation system for green cooling purposes or use of a portable watering tank. Suitable backflow prevention measures must be incorporated into the design to prevent backflow or siphonage into the potable water system. The effluent irrigation system must be drained prior to connection with any potable water source.

³ Irrigation oriented systems shall provide tailwater management or facilities unless applied runoff meets permit effluent limitations and would directly enter a defined water course.

⁴ Volume of the secondary treatment cell, above the 2 foot level, of a lagoon system may be utilized for storage.

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XIV. LABORATORY REQUIREMENTS

A. Requirement for Laboratories

All wastewater facilities shall be equipped with laboratory facilities capable of analyzing parameters vital to successful plant operation with the exception of the following; for non-overflowing waste stabilization ponds, for facilities serving a population equivalent of 10 or less, or for facilities where testing is to be conducted at another facility or commercial laboratory. If a wastewater management agency controls several treatment facilities a central laboratory may be utilized. Regionalization of laboratories by several wastewater management authorities is acceptable if reasonable travel distances are involved. Multipurpose laboratories may be developed to allow an authority (municipality) to combine laboratory functions. The laboratory may be contained within an administration building, mechanical building, or other suitable structures. It is not required that the laboratory be on-site although it's highly recommended. (See chapter entitled "General Design Considerations for Sewage Treatment Works")

B. General Laboratory Considerations

The characterization of wastewater, whether it be domestic or industrial in origin, begins with the sampling and analyses of that wastewater. Careful consideration should be given to the laboratory facilities necessary to provide proper operational control of the plant. A laboratory which is thoughtfully planned, well equipped, and competently staffed is the process control center of the plant. The data obtained from the sampling and testing program may be utilized in evaluating plant and unit process performance efficiencies, characterizing the raw waste and controlling effluent quality, insuring compliance with regulatory requirements and reporting operational trends, predicting potential difficulties and suggesting operational changes which will prevent or solve difficulties when they occur, and providing data for future design considerations.

C. Analyses

The extent of any testing program should depend on the size and type of the treatment facility, regulatory requirements, and the time and manpower which can be made available for that purpose. A suggested minimum sampling program is provided outlining unit processes, tests to be run, and the testing frequency. Test procedures for the analysis of the parameters listed shall conform to techniques outlined in the latest edition of "Standard Methods" and other approved techniques.

D. General Laboratory Design

A well designed wastewater treatment plant laboratory has flexibility, adaptability and expandability designed into it. The laboratory should be located on ground level and be directly accessible from the outside of the plant. If at all possible, the laboratory should have a northerly exposure to light, and should be located away from vibrating machinery or equipment which might have an adverse effect on the performance of laboratory instruments or the analyst. The laboratory should provide a pleasant, comfortable environment in which the analyst may work.

SUGGESTED MINIMUM LABORATORY ANALYSES FOR TYPICAL PROCESSES

Process & Tests	Sample Type	Plant Capacity MGD			
		0.05	0.50	1.0	5.0 & Over
<u>All Types of Plants*</u>					
BOD ₅					
Influent	c	--	w	d	dw
Effluent	c	--	w	d	dw
Total Suspended Solids					
Influent	g	--	w	tw	d
Effluent	g	--	w	tw	d
Volatile Suspended Solids					
Influent	g	--	w	tw	d
Effluent	g	--	w	tw	d
Chlorine Residual**					
Effluent	g	tw	d	d	dw
pH					
Influent	g	tw	d	d	dw
Effluent	g	tw	d	d	dw
D. O. (Dissolved Oxygen)					
Effluent*	g	tw	d	d	dw

*Excluding non-overflowing waste stabilization ponds.

**For plants practicing chlorination.

Laboratory Requirements
Adopted 8-17-78

Process & Tests	Sample Type	Plant Capacity MGD			
		0.05	0.50	1.0	5.0 & Over
PRETREATMENT					
Grit Removal					
Volatile Solids (In Grit)	g	m	w	tw	tw
Primary & Final Sedimentation - PRIMARY TREATMENT					
BOD ₅	g	m	w	w	tw
Total Suspended Solids	g	m	w	w	tw
Activated Sludge - SECONDARY TREATMENT					
All Aeration Compartments					
Mixed Liquor D.O.	g	d	d	d	dw
Mixed Liquor Solids	g	--	tw	d	dw
Suspended Solids	g	d	d	d	dw
Sludge Settleability	g	d	d	d	dw
Volatile Suspended Solids	g	--	tw	d	dw
Return Sludge Mixed Liquor Suspended Solids	g	d	d	d	dw
Microscopic Examination of the Mixed Liquor Suspended Solids	--	d	d	d	dw

Trickling Filter					
BOD ₅	g	m	w	w	tw
SOLIDS HANDLING					
Anaerobic Digesters					
pH	g	--	d	d	d
Alkalinity	g	--	w	tw	d
Total Solids	g	--	w	w	w
Volatile Solids	g	--	w	w	w
Volatile Acids	g	--	w	w	w
Temperature	g	--	d	d	d
Aerobic Digesters					
Total Solids	g	--	w	w	w
Total Volatile Solids	g	--	w	w	w
Total Suspended Solids	g	--	w	w	w
Volatile Suspended Solids	g	--	w	w	w
Dissolved Oxygen	g	d	d	d	dw
Sludge Settleability	g	d	d	d	dw

Laboratory Requirements
Adopted 8-17-78

m - monthly	dw - daily (Monday through Sunday)
tw - twice weekly	c - 24 hour composite sample related to flow
w - weekly	g - grab sample during the
d - daily (Monday through Friday)	loading hours.

maximum

To more accurately assess unit process performance, it is recommended that the suggested tests be taken for both the influent and effluent of each unit process. For the purposes of this table, a completely mixed aerated pond is considered to be an activated sludge process. A facultative aerated pond is to be considered a waste stabilization pond. An anaerobic pond is to be considered an anaerobic digester.

E. Design Recommendations

A minimum of 400 square feet of floor space should be allocated for the laboratory. If more than one analyst will normally be working in the laboratory at any given time, one hundred (100) square feet of additional space per each additional person should be allowed. Aisle space of not less than 4 feet and preferably 5 feet should be employed. Wall space for cabinets, benches, hoods, incubators, etc., require as much consideration and planning as that put into planning the floor space. The ceiling height should be such that the installation of wall mounted water stills, distillation racks, and other equipment with extended height requirements will not be hindered.

1. Ceilings

Accoustical tile should not be used in high humidity areas of the lab.

2. Walls

The interior walls shall be constructed of such materials or finished in such a manner as to provide for easy maintenance.

3. Floors

The floor surfaces should be fire resistant and highly resistant to acids, alkalies, solvents, and salts. The surface shall be serviceable, provide good footing, and easily kept clean.

4. Doors

Doors shall be located to permit a straight egress from the laboratory. They should have large glass windows for easy visibility of approaching or departing personnel. Flush hardware should be provided on doors if excessive cart traffic is anticipated. Kick plates are also recommended.

5. Lighting

Ample lighting is very important. This calls for reasonable window space for daylight and ample artificial lighting for night work. Special lights over the balance and on the inside of the fume hood are useful provisions. A generous number of wall receptacles should be provided for all useful electrical services, i.e., 110, 220, etc.

6. Benches and Tables

Approximately 100 square feet of work table or bench area should be provided per worker. Tables or benches used in a standing position are 36 to 38 inches high; those used in a seated position, 30 to 32 inches high. The table or bench top should be constructed of materials that are fire resistant and highly resistant to acids, alkalies, solvents, salts, and easily cleaned.

7. Reagent Cabinet

A special cabinet for the storage of stock chemicals and standard solutions should be provided. Narrow shelf widths, 6 to 12 inches, should be employed so that chemicals and reagents are in full view when the cabinet is opened. Opaque doors may be employed to protect against the action of light with chemicals and reagents. All cabinet shelving should be resistant to acids, alkalies, solvents, and salts. The shelving should be adjustable from inside the cabinet.

8. Storage Cabinets

Wall hung or cupboard style base cabinets should be provided for storing large items and equipment. All drawers in the base cabinets should be provided with rubber bumpers and with stops which prevent accidental removal.

9. Sinks and Plumbing

Where no more than two people are normally working in the laboratory, a centrally located sink will suffice as a minimum. It is desirable to provide a second sink for washing and soaking sample bottles and glassware. The sinks should be constructed of materials highly resistant to acids, alkalies, solvents and salts. The material should resist abrasion, be heat resistant, and non-absorbant. Sink drains inside of the building are to be constructed of non-corrosive materials, i.e., glass, stoneware, lead, etc. The sinks should be deep enough to wash tall or elongated pieces of glassware or equipment.

10. Fume Hoods

Fume hoods are required in laboratories where there will be the potential for toxic fumes, odors, or excessive condensation on windows or walls. The fume hoods should be located where air disturbance at the face of the hood is minimal. Bench or table surfaces should be available next to the hood so that chemicals need not be carried long distances.

11. Ventilation

Separate exhaust ventilation shall be provided for the laboratory.

12. Gas

Natural gas may be supplied to the laboratory. Digester gas shall not be used.

13. Record Storage

Suitable facilities shall be provided for the storage of records for a minimum of 3 years.

14. Safety Equipment

The laboratory should be equipped with an emergency eyewash, fire extinguisher, and first aid kit suitable for chemical burns. Strongly recommended items are an emergency shower and fire blanket.

15. Laboratory Equipment

The laboratory equipment to be provided shall be consistent with that specified in the most current edition of "Standard Methods".

State of Kansas . . . ROBERT F. BENNETT, Governor

DEPARTMENT OF HEALTH AND ENVIRONMENT

DWIGHT F. METZLER, Secretary

Topeka, Kansas 66620



WATER QUALITY POLICY MEMORANDUM

Series #1-77

PURPOSE: To establish a procedure for publicizing the policy position of the Bureau of Water Quality, Division of Environment with respect to various water quality management issues.

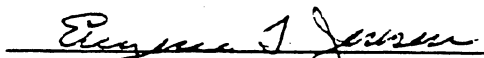
BACKGROUND: State and Federal legislative actions have resulted in the adoption of a complex series of programs designed to abate pollution and to assure water quality in the future. These programs include elements of planning, operation and maintenance of sewerage facilities, financial assistance for the construction of a municipal sewerage facilities, extension of municipal sewerage systems, protection of groundwater, investigation of fish-kills, and prevention and clean-up of oil spills. It is essential from both environmental and financial management standpoints that these various program elements be articulated.

POLICY: The Bureau of Water Quality hereby establishes a system of numbered memoranda whereby Bureau Policy with respect to its various water quality programs will be defined. Water Quality Policy Memoranda will be numbered sequentially, will be revised from time to time, and an up-to-date index will be maintained.

A regular mailing list will be established whereby copies of each Water Quality Memoranda may be distributed to all interested parties.

Issues which may be the subject of a Water Quality Policy Memoranda should be brought to the attention of the Bureau of Water Quality for appropriate action. The Bureau of Water Quality will consider such requests from any individual or organization having a proper interest in water quality management within Kansas and who is willing to prepare background material explaining the need for a Water Quality Policy Memorandum. Any such requests should be directed to: Director, Bureau of Water Quality, Department of Health and Environment, Topeka, Kansas 66620.

Effective date: March 31, 1977.


Eugene T. Jensen
Director

TRICKLING FILTERS

PURPOSE: To set forth the position of the Bureau with respect to the award of Federal financial assistance for the replacement or upgrading of municipal wastewater systems incorporating a trickling filter in the treatment processes.

BACKGROUND: The trickling filter has long been recognized in Kansas as an effective, easy-to-operate, economical wastewater treatment system, and about 178 such systems are now in operation. However, many of the systems do not meet the statutory requirements for secondary treatment or discharge permit limitations and some form of upgrading is required. It does not seem reasonable to make extensive capital expenditures for complete system replacement, or to increase operating costs significantly if satisfactory effluent results can be obtained through other means.

Methods resulting in significantly increased operational, manpower, or energy costs, or complexity of operation, should be considered only after other less operator or energy intensive methods have been fully evaluated and deemed insufficient to meet upgrading requirements.

The Federal Water Pollution Control Act Amendments of 1972, require that: "For publicly owned treatment works in existence on July 1, 1977, or approved pursuant to Section 203 of this Act prior to June 30, 1974 (for which construction must be completed within four years of approval), effluent limitations based upon secondary treatment as defined by the Administrator pursuant to Section 304(d)(1) of this Act; or, not later than July 1, 1977, any more stringent limitation, including those necessary to meet water quality standards, treatment standards; or schedules of compliance, establishment pursuant to any State law or regulations (under authority preserved by Section 510) or any other Federal law or regulation, or required to implement any applicable water quality standard established pursuant to this Act".

In accordance with this statutory mandate, the Environmental Protection Agency has adopted regulations generally defining secondary treatment as wastewater effluent with not more than 30 mg/l of BOD₅ and suspended solids. There is, as of the date of this Policy Memorandum, an indication that EPA may relax the definition of secondary treatment as applied to small communities using waste treatment ponds.

All point source discharges in Kansas are required by State and Federal law to hold a valid National Pollutant Discharge Elimination System (NPDES) discharge permit, and to comply with effluent limitations as set forth in the permit.

Wastewater systems incorporating a trickling filter may be placed in one of the following categories:

Category A - Facilities in good physical condition, operated at less than 80% of capacity (hydraulic and organic loading design), and are properly operated and maintained; effluent discharges which, on a yearly average, are less than 30 mg/l of BOD₅ and suspended solids, and BOD₅ and suspended solids discharges do not exceed 45 mg/l oftener than one reporting period per calendar year; and, water quality standards are not violated.

Category B - Facilities which are in good physical condition, are properly operated and maintained, are operated at less than 80% of hydraulic and organic design loadings, but which have an effluent with a BOD₅ and/or suspended solids concentration greater than 30 mg/l each, more often than once per reporting period, but only exceed 45 mg/l BOD₅ and/or suspended solids occasionally; and, there is no evidence of consistent water quality violations.

Category C - Facilities which have deteriorated physically to the point that they are no longer operable or are in imminent danger of failure, or facilities which are operable but are, in reality, obsolescent and cannot be maintained and operated in such a way that the discharge limitations will be met consistently; or hydraulic and organic loadings are 80% or greater of design loadings and need for increased capacity over a realistic design period can be shown, or existence of a major safety hazard, which cannot be readily corrected, or the lack of flexibility which severely limits the reliability of the system, or significant violation of water quality standards attributable to the discharge, or consistent and significant violations of the discharge permit conditions.

POLICY:

1. The policy of the Bureau of Water Quality with respect to funding construction for the above categorized wastewater treatment works will be as follows:

Category A - Encourage the owner to eliminate the BOD₅ and suspended solid excursions through improved operation and maintenance and minor plant improvement, and to refrain

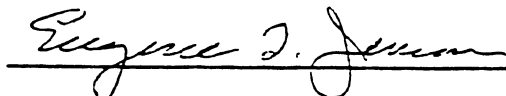
from directing or requiring additional construction. The discharge will not be classified as a significant violation of permit conditions under enforcement criteria, contingent upon the owners cooperation in seeking satisfactory operations.

Category B - To require that the owner employ a consulting engineering firm to make a detailed study, including a cost-effective analysis of opportunities for limited upgrading of the existing treatment plant. Elements to be considered in such an analysis include, but are not necessarily limited to: increased or improved recirculation; conversion to two stage filtration; additional pre-treatment or post-treatment units including lagoons, or surge basins; filter enclosures; fixed or rotating biological contactors; and/or chemical addition.

Category C - Require total replacement or major upgrading of the facilities, which will, upon replacement or upgrading, be expected to meet the effluent limits as set forth in the discharge permit.

2. The Bureau of Water Quality will observe the above policy declaration in the review of engineering facilities plans and specifications, and formulation or revision of water quality management plans.
3. The Bureau of Water Quality will observe EPA guidance in preparation of Needs Assessment as required by P.L. 92-500, The Federal Water Pollution Control Act Amendments of 1972.

EFFECTIVE DATE: April 6, 1977



Eugene T. Jensen, P.E.
Director
Bureau of Water Quality

CONSTRUCTION AND PERMITTING OF WASTEWATER TREATMENT FACILITIES

PURPOSE

To set forth the position of the Bureau with respect to approval for location, construction, and permitting of new, expanded, or relocated municipal, industrial and commercial wastewater collection and/or treatment facilities within or adjacent to existing sewer service areas.

BACKGROUND

The Kansas Division of Environment is responsible for the protection and enhancement of the quality of the State's waters through the judicious application of water quality standards, effluent standards, and engineering design criteria. The Division's policies regarding the aforementioned standards are developed and integrated through the State Water Quality Management Plan. The State Water Quality Management Plan prepared under the requirements of Section 303e, P.L. 92-500 and 40 CFR 130 and 131, sets forth the general framework for making sound water quality decisions and for establishing and implementing effective control programs at the State and local levels. The Division's Point Source Water Quality Management Plans (adopted November 1, 1976*) are the first output of the State Water Quality Management Plan and generally set forth the Division's program for achieving the 1977 water quality goals of P.L. 92-500. Water Quality Management is a dynamic process and revisions and amendments to the State Water Quality Management Plan are made as needed.

Although the Division of Environment is responsible for the water quality of the entire State, successful protection of existing high quality waters and restoration of polluted waters can only be achieved through the cooperative efforts of State and local government. An issue which demands attention is the location and construction of wastewater collection and treatment systems in urbanizing areas adjacent to many cities. In many cases, rapid urbanization and industrialization in these areas create serious water quality management problems through the proliferation of relatively small, poorly operated, and maintained wastewater facilities. This situation can result in serious deterioration in the quality of surface and groundwater, public health hazards, community nuisances, and poor and ineffective utilization of limited water pollution abatement funds. Additional difficulties including conflicts over jurisdiction, financing a competent operations and maintenance staff, and long range planning occur when different governmental entities or ownerships are responsible for the systems.

The economic impact of the establishment of numerous small temporary treatment facilities cannot be overemphasized. This procedure may eventually lead to repeated assessments of cost to citizens being served by the facilities for larger "temporary" treatment units, interceptors for transportation of wastewaters to larger permanent treatment facilities, and for treatment capacity in

*Metro Area Supplements Adopted May 9, 1977.

the larger permanent facilities. The capital and operating costs of any temporary treatment facility must be kept to a minimum while at the same time maintaining adequate engineering design. Long-term financing, which would exceed the anticipated life of the facility, should be avoided to minimize future public complaints on redundant sewerage charges. If abandonment must occur prior to payout, the citizen will again be penalized through multiple assessment of costs. Economic planning is an absolute necessity.

In analyzing this situation, the Bureau of Water Quality considered the following situations:

1. Existing and proposed systems for areas entirely within existing sewer service areas (e.g., within city limits, existing county sewer district, improvement district, etc.).
2. Existing and proposed systems adjacent to an existing sewer service area.
3. Existing and proposed systems which overlap governmental jurisdictions.

The following policy is based in part on the establishment of the Kansas Water Quality Management Plan pursuant to 40 CFR 130 and 131 and P.L. 92-500 and their modifications or amendments. The policy also is based on Kansas Regulation 28-16-62 (adopted April 24, 1974), Terms and Conditions of Permits, I., Prohibitions, which states, "No permit shall be issued if the discharge is in conflict with an approved plan designated pursuant to the Act".

POLICY

The following policy will be observed by the Bureau of Water Quality with respect to the approval for location, construction, and permitting of wastewater collection and/or treatment facilities within facility planning areas as identified in the State Water Quality Management Plan and within a three-mile limit from existing city boundaries, if not covered in the previously designated facilities planning area:

1. New wastewater permits will not ordinarily be issued for locations, within city limits, county sewer districts, improvement districts, or large drainage districts within the boundaries of these areas, where adequate sewers and treatment facilities exist. Modifications or additions to existing treatment facilities will be considered on a case-by-case basis taking into account possibilities of regionalization, inter-connection, service areas, required treatment levels, and water quality standards.
2. Approval of initial proposals, plans and specifications will not be given for any proposed facilities in locations adjacent to established wastewater collection and treatment service areas which could be routinely served by existing facilities based on technical considerations, contractual arrangements, and fair and equitable capital and

and service charges. Where a reasonable potential exists for new interceptors and/or treatment facilities, and where it has been determined that an existing system cannot routinely handle the additional wastewater flow, permits may be issued for temporary treatment facilities which will utilize construction of a temporary nature. No permanent facilities shall be constructed.

For purposes of this policy statement, the following characteristics will generally define "temporary" design and construction:

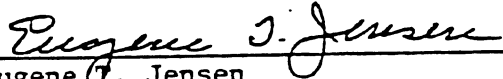
- a. The facility will have a limited design life of 4-7 years, maximum, prior to abandonment, relocation, or alternative means of transport and treatment.
- b. Individual units and piping will be designed to facilitate abandonment and connection to intercepting sewers.
- c. The design of temporary facilities will attempt to limit capital costs and will utilize treatment concepts which would result in reduced operation and maintenance costs for the life of the project.
- d. Non-discharge, discharge, or aerated variations of lagoon treatment systems will be considered as initial alternatives for temporary treatment systems. Mechanical systems will be considered as second alternatives.
- e. Temporary treatment sites will be designed for reclamation of land following abandonment of the facilities.
- f. Phasing must be considered in all temporary treatment situations. Adequate data should be presented to the Bureau of Water Quality relating to estimated growth rates and treatment needs for each year during the life of the temporary treatment facility.

Permits will be written to reflect the eventual abandonment and transport of wastewaters to other nearby collection and/or treatment facilities, and will include requirements for an annual reporting of progress toward abandonment. Temporary permits will not be issued on a routine basis.

3. In areas where no treatment facilities currently exist and access to existing or proposed interceptors and treatment facilities will not be available due to technical and/or financial constraints, permits may be issued, if the public health is subserved and established water quality standards are met. The permits may contain conditions for eventual abandonment or transport of wastewater to other locations. These conditions will be determined on a case-by-case basis.
4. Individual consideration will be given to requests from industrial and commercial establishments for discharge permits where process and/or contaminated cooling water treatment may be subject to requirements or pretreatment programs which may be as stringent as direct discharge requirements.

5. Permits may be issued for the discharge of uncontaminated cooling waters regardless of location.
6. The Bureau of Water Quality will review all initial proposals for the new wastewater treatment systems in accordance with Section I (Facilities Plan), Minimum Standards of Design for Water Pollution Control Facilities, adopted October 15, 1977, in accordance with K.S.A. 65-171h and the applicable section of the Kansas Water Quality Management Plan. Approval to proceed with new treatment facilities will not be routinely given.
7. It is strongly recommended that all proposals for new wastewater facilities (other than sewer extensions) be discussed in detail with the Bureau of Water Quality staff prior to implementation of financial or real estate transactions which may commit owners or consultants to monetary and time constraints.

This policy statement will serve as an amendment to each 303e Point Source Water Quality Management Plan adopted as of November 1, 1976*.



Eugene J. Jensen
Director, Bureau of Water Quality
Kansas Department of Health & Environment

*Metro Area Supplements Adopted May 9, 1977.

DESIGN, REVIEW, APPROVAL
CONSTRUCTION, AND PERMITTING OF SEWER EXTENSIONS

PURPOSE

To set forth the position of the Bureau with respect to the design, review, approval, permitting and construction of the extension of sewer lines (gravity), pump stations, and force mains for municipal, commercial and industrial sewage systems.

BACKGROUND

The Water Pollution Control Section, Bureau of Water Quality, currently processes approximately 300-400 sewer extensions per year in accordance with the provisions of K.S.A. 65-165 and 65-166. These projects range from simple three hundred foot lateral extensions to major interceptor systems combined with large pumping facilities. The size, complexity, and engineering requirements tend to be unique in most cases. This situation gives rise to the need for broad but technically correct procedures for design and review.

The rapidly expanding nature of our cities, subdivisions and industries has necessitated the concurrent expansion of utilities of all types. The expansion has greatly influenced the technical review workload and procedures of the Division of Environment.

The rapid expansion in the use of new materials and construction procedures has prompted a continual need for updating regulatory review and approval requirements. With these items in mind, the Bureau of Water Quality has placed great emphasis on the design and construction of sanitary sewers via the recently published "Minimum Standards of Design for Water Pollution Control Facilities".

Of major concern has been the use or non-use of sewer extensions as a tool to control and implement the management and production of high quality effluents from wastewater treatment plants. Too often in past years, approval has been given without adequate regard for the effect on downstream receiving sewers, pump stations, and the effect on actual treatment plant capabilities. By more carefully matching plant capabilities with projected wastewater input, system managers can make necessary decisions on additional transport and treatment capacity, and the quality and efficiency of treatment plant processes. However, in those instances where local wastewater management is not aware or does not see fit to initiate action, the Bureau of Water Quality may implement restrictions on sewer construction while at the same time modifying existing wastewater permits to reflect the need for greater capacity or higher, more efficient levels of treatment.

The economics involved in the collection and transport of the wastewaters dictates the need to reduce extraneous water from the sewer system. Added costs for maintenance, pumping, and treatment can be drastically reduced through adequate design, construction, and inspection.

In reviewing the above concerns, the Bureau of Water Quality considered the following areas of concern:

1. Implementation of more stringent effluent quality standards for wastewater treatment facilities and the ability of existing treatment plants to meet the NPDES permit requirements.
2. Increased emphasis on the prevention of bypass and surcharge conditions resulting in the discharge of untreated wastewaters to receiving streams.
3. The continuous and varied nature of sewer extension submittals.
4. Recent issuance and adoption of "Minimum Standards of Design for Water Pollution Control Facilities" by the Kansas Department of Health and Environment.
5. Increased emphasis on the reduction of operation and maintenance costs associated with infiltration/inflow resulting from inadequate design, construction, and inspection.
6. Increased emphasis on adequate future planning with respect to interceptor and treatment plant loadings and capabilities.
7. Advancing technology with respect to installation, pipe materials, and cost factors.
8. Operator certification regulations and the ever increasing emphasis on increased collection system operation and maintenance.

The following policy is based in part on K.S.A. 65-165, K.S.A. 65-166, Kansas Department of Health and Environment Regulation 28-16-55, and the establishment of the Kansas Water Quality Management Plan pursuant to 40 CFR 130, 131, and Public Law 92-500.

POLICY

The following policy will be observed by the Bureau of Water Quality with respect to the approval of design, construction, and permitting of gravity or force main sewer extensions of existing wastewater interceptor and collection systems for municipal, commercial, and industrial systems:

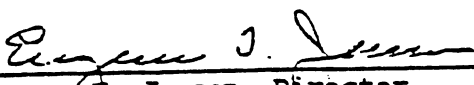
1. The Bureau of Water Quality will establish more stringent procedures for the engineering review of sewer extensions. The review procedures will implement the appropriate requirements for sewer extensions found in "Minimum Standards of Design for Water Pollution Control Facilities". This action will be accompanied concurrently by a modified review format, new application and a combined approval and permit form.
2. All engineering consulting firms and city engineers engaged in the design of sanitary sewer extensions are requested to submit a standard set of specifications covering all generalized sanitary sewer extension materials

and construction procedures prior to March 1, 1978. Design and construction elements unique to each job; i.e., lift stations, siphons, etc., must be covered by addendum to the specifications at the time of submittal of the plans for the project. The standard specifications and its addenda must conform to the Division of Environment's "Minimum Standards of design for Water Pollution Control Facilities". Future revisions to this document shall be forwarded to all consultants, municipalities, etc. At that time, appropriate revisions must be initiated for the standard specifications utilized.

3. As of March 1, 1978, sewer extension submittals which reference previous project specifications will not be accepted unless a revised set of specifications has been furnished to the Water Pollution Control Section. The revised set will be kept on file and utilized as a reference by review engineers.
4. Approval of any sewer extension project will be contingent not only upon an engineering review to assure conformance with the appropriate standards, but also upon the completeness and accuracy of the sewer extension permit application.
5. Emphasis will be placed on the construction inspection of the sewer extension. Random inspections by Bureau of Water Quality personnel will be initiated. Inspection of job sites which reveal no inspector present will initiate steps to restrict construction until such time as adequate inspection is provided in accordance with Kansas Department of Health and Environment Regulation 28-16-55.
6. Only one (1) set of sewer extension plans need be submitted for each project. At least two (2) additional plan and specification cover sheets should be submitted. These items must be stamped by a professional engineer licensed in the State of Kansas or they will be returned without review. These items will be stamped and returned. The submitted set of plans will be utilized for review and microfilming.
7. Upon completion of the sewer extension project, an as-built set of plans shall be submitted for microfilming if major modifications via addenda or change order have occurred. Written certification, by the licensed engineer or responsible agency in charge of the project, indicating that the extension was constructed in accordance with the plans and specifications must also be furnished to the Division of Environment upon completion of the project.
8. Careful comparisons will be made of existing transport and treatment systems with proposed extensions to determine the acceptability of the requested extensions. In cases where additional extensions could have potential for disrupting treatment plant efficiency, capacity, and effluent quality, steps will be taken to restrict extension of the system, and appropriate steps will be taken via NPDES and State of Kansas permits to initiate needed engineering and construction.
9. Large cities, sewer districts, or industries which have in-house engineering capabilities may design and have constructed sewer extensions provided the following conditions are met:

- a. A written agreement between the entity and the Bureau of Water Quality has been consummated.
 - b. Standardized specifications will conform to or be more stringent than the conditions contained in "Minimum Standards for the Design of Water Pollution Control Facilities". The specifications will be submitted to the Water Pollution Control Section for review and approval.
 - c. The concerned entity shall certify to the Bureau of Water Quality that full time qualified inspection will be provided in accordance with Regulation 28-16-55.
 - d. Each entity shall provide a semi-annual summary of all sewer extensions constructed. This should include a listing of lines, sizes, and design flows. An appropriate system map showing the additions must also be provided. Permits for these lines will be issued upon review of the summaries.
10. Sewer extension permits will not be issued if the receiving wastewater treatment plant is in violation of its NPDES or State of Kansas permit.
 11. Sewer extension permits will not be issued if the receiving wastewater treatment plant does not have a certified operator as required by Kansas Department of Health and Environment Regulation 28-16-29.

This policy statement will become effective on the indicated date and will serve in conjunction with the revised application and review formats, as the working policy of the Bureau.



Eugene T. Jensen, Director
Bureau of Water Quality
Kansas Department of Health & Environment

PUBLIC HEALTH HAZARD QUANTIFICATION

PURPOSE: To set forth the procedure to be used by the Bureau of Water Quality in evaluating the extent to which public health hazards associated with sewage collection and treatment determine municipal priority for award of an Environmental Protection Agency sewerage grant.

BACKGROUND: The Municipal Construction Grant Priority System was adopted by the Kansas Department of Health and Environment following public hearings held on June 28, 1977 and July 12, 1977. This priority system is based in part upon a system of environmental priorities including credits for "Protection of the Public Health". The priority system contains detailed instructions for calculating the priority points awarded for items such as court orders, administrative proceedings, severity of pollution, population affected, population connected, and improvement factor. However, the system does not incorporate detailed instructions for "Protection of Public Health". It is the purpose of this Water Quality Policy Memorandum to set forth the procedures which will be observed in calculating the supplemental score to be awarded on Part IV, Protection of Public Health, Section 10, Kansas Municipal Sewerage Priority System.

POLICY:

1. An actual outbreak of disease attributed to waste disposal practices is justification for invoking the public health hazards clause incorporated in Part I of the priority system. Such an outbreak is also justification for awarding the full 10% supplemental credit (Item 10).
2. The following instructions will be observed by the Bureau of Water Quality in identifying a public health hazard and in calculating the supplemental score for use in the priority determination of each project.
 - I. Subsurface conditions. A maximum of 10% will be awarded if one or more of the identified conditions is present:
 - A. Subsurface conditions preclude the use of soil absorption or other methods of underground disposal based upon:
 - a. Presence of soil having a percolation rate of greater than 60 minutes per inch; or

- b. A groundwater table within six (6) feet of the surface; or
 - c. Extensive strata of limestone or fracture rock that extends from within six (6) feet of the ground surface to an underground aquifer.
 - d. The presence of underground cavities, shafts, or tunnels created by mining or the removal of material.
- II. Contamination of Individual Water Supplies. A maximum of 10% will be awarded if the following condition is present:
 - A. Significant number (greater than 25%) of properly constructed individual water supply wells within the area are contaminated as shown by bacteriological or chemical examination.
- III. Contamination of Water Supply. The presence of any one of the three conditions identified in subparagraphs A, B, or C is justification for increasing the preliminary score by 10%.
 - A. Individual subsurface soil absorption systems are underlain by a shallow aquifer, and fecal coliform organisms in amounts greater than two per 100 millimeter and/or nitrates in excess of 10 milligrams per liter (expressed as N) are found in the aquifer.
 - B. Significant concentrations of subsurface soil absorption systems or other individual waste treatment systems are situated within a horizontal distance of 1,000 feet of a well penetrating an unconfined aquifer which serves as a community water supply, and at such an elevation that groundwater movement is most likely toward the community water supply.
 - C. Wastes are discharged directly into abandoned mine workings.
- IV. Environmental Effect. Existence of any of the conditions described in subparagraphs A, B, or C shall provide justification for increasing the preliminary priority score by 10%.
 - A. Septic tank effluent or leachate or untreated wastes are discharged into a body of water capable of providing for and designated for full or partial body contact.

- B. There is extensive and substantial pooling on the ground surface of sewage from onsite systems and which thereby provide an opportunity for direct human contact with micro-organisms and/or provide breeding grounds for disease vectors.
- C. Septic tank effluent or leachate or untreated waste is discharged into a body of surface water used for public or private water supply.

V. Bypassing.

Bypassing of untreated sewage at the treatment plant, pumping stations or other overflow points in the sewerage system including combined systems, uncontrolled overflows through manholes, or back up of untreated sewage into basements.

The preliminary priority score may be increased by 10% if bypassing occurs on a routine basis. Emergency bypassing during periods of catastrophies, such as tornados or floods, does not qualify the project for a priority score increase. A partial score may be awarded if the bypassing is infrequent or extremely limited in quantity or is into waters which are not generally accessible.

- VI. The total additional incremental score allowable for "Protection of the Public Health" is limited to 10% of the "preliminary priority score" as set forth in the priority system.

January 17, 1978
Effective date

Eugene J. Jensen
Director, Bureau of Water Quality

ENGINEERING OBSERVATION OF WASTEWATER CONSTRUCTION PROJECTS
KANSAS DEPARTMENT OF HEALTH AND ENVIRONMENT
REGULATION (K.A.R.) #28-16-55

PURPOSE

To set forth the position of the Bureau of Water Quality with respect to the construction observation of wastewater collection and treatment facilities.

BACKGROUND

Kansas Department of Health and Environment Regulation K.A.R. 28-16-55 (Kansas Administrative Regulation) entitled, "Inspection of Sewerage Systems During Construction and Prohibited Connections", reads in part:

"II. Inspection of Sewerage System Construction

A. Treatment Facilities, Mains, and Laterals

All sewerage construction projects shall have continuous inspections by a qualified inspector during active phases of sewerage construction to insure that they comply with plans and specifications approved by the Kansas (State) Department of Health (now Kansas Department of Health and Environment) and to insure elimination of extraneous surface and groundwater. This shall include inspection of all sewers and manholes before they are covered but after the sewers are bedded."

With the tremendous amount of construction currently taking place, there has been some confusion as to the requirement for engineering observation. Certain contradictions may be interpreted from the above referenced segment of the regulation; therefore, clarification is desirable. Owners, contractors and consulting engineers have raised questions as to the nature and coverage of engineering observation required to comply with the regulations.

Experience has demonstrated that inadequate observation of construction can cause serious economic hardships and does little to alleviate pollution problems.

POLICY

The following policy will be observed by the Bureau of Water Quality with respect to the requirements for the engineering observation of the construction of all wastewater collection and treatment facilities:

1. The Bureau of Water Quality will interpret and enforce the following definitions of certain key words contained within the body of Regulation 28-16-55, Paragraph II.A.:

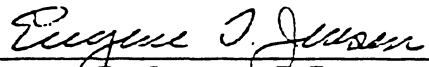
- a. "Shall": The word "shall" is a mandatory term. (Ref. 28-16-55, Paragraph I.L.).
- b. "Continuous": The word "continuous" is defined as a physical presence, on the job site(s), of a qualified observer while active phases of construction are in progress.
- c. "Inspector": An inspector shall be a consulting engineer, municipal engineer, sewer district engineer, county engineer, or their authorized representative. (Ref. 28-16-55, Paragraph I.g.).
- d. "Observer": The word "observer" will be substituted for the word "inspector". They will be considered as synonymous except that the use of the word observer will not imply or be defined as being responsible for the quality of contractor work.
- e. "Qualified": The word "qualified" is defined as an observer with an engineering degree and sewer construction training and experience, an engineering technician or aide with sewer construction training and experience, or an authorized representative who has construction background and training in sewer construction.
- f. "Active Phases": The phrase "active phases" is defined to include the following construction activities:
 1. pipelaying: alignment, grade, embedment and jointing procedures
 2. trench backfill
 3. testing - air, hydrostatic, lamping, deflection, and TV
 4. appurtenant construction* - manholes, cleanouts, junction or control structures, wet wells, dry wells, etc.
 5. treatment unit construction* - grit chambers, headworks, sedimentation basins, aeration basins, clarifiers, contact basins, digesters, etc.
 6. any other construction activities specifically outlined in contract documents by the owner.

*To include placement of forms, reinforcing steel, concrete, and installation of process equipment.

2. Where treatment plants and large pumping facilities are under construction, continuous engineering observation shall be provided for all active phases of the construction.

3. Observation of building sewer service connections will be assumed to be the responsibility of the owner unless specified otherwise in the project contract and specification documents.
4. Construction sites will be visited by Bureau of Water Quality staff on a random basis to determine the presence of proper engineering observation.
5. Enforcement authority of the Division of Environment may be utilized where random checks by Bureau of Water Quality staff disclose lack of proper engineering observation or lack of response on the part of the engineer or owner in providing proper engineering observation.
6. All observers must keep a daily log of activities concerning the job site(s) entrusted to their responsibility. This log must be available upon request for review by Bureau of Water Quality staff.
7. The Bureau of Water Quality recommends that preconstruction photographs be taken of all sites and maintained for reference to aid the owner, observer, and engineer in resolving any disputes concerning construction activities and site restoration.

January 18, 1978
Effective Date



Eugene T. Jensen, P.E.
Director, Bureau of Water Quality
Kansas Dept. of Health & Environment

IRRIGATION USE OF MUNICIPAL WASTEWATER EFFLUENTS

PURPOSE

To set forth the policy of the Bureau of Water Quality with respect to the use of effluent from municipal wastewater treatment plants for irrigation of publicly or privately owned and frequented properties. Additionally, this policy will amend portions of the Minimum Standards of Design for Water Pollution Control Facilities, Section IX, entitled "Agricultural Application of Wastewater or Sludge".

BACKGROUND

The use of wastewater effluents from municipal wastewater treatment works for the irrigation of agricultural and municipal properties has been extensively practiced throughout the world for many years. This process, properly controlled and conducted, adequately protects the public health, effectively prevents degradation of surface waters, and efficiently utilizes water and nutrient resources.

The Federal Water Pollution Control Act, P.L. 92-500 and recent amendments, P.L. 95-217, place great emphasis on waste treatment systems which make constructive use of wastewater effluents. Under current EPA regulation, projects incorporating such concepts may receive more favored financial support than those based on discharge to surface waters. Consistent with this emphasis and the Kansas Water Pollution Control and National Pollutant Discharge Elimination System permit programs, irrigation projects for municipal effluent may be characterized as follows:

1. Treatment oriented, (no direct point discharge to waters of the State): where irrigation of wastewater effluent is an integral component of the overall treatment process and is employed to eliminate point source discharges to waters of the State.
2. Irrigation oriented, (periodic point discharge to waters of the State): where treated effluent is utilized as needed for supplemental water and where the treatment system can meet NPDES effluent limitations for discharge to waters of the State.

The design of irrigation systems utilizing municipal effluents must carefully interrelate public health, water pollution, land conservation, and other legal and environmental considerations. These considerations are discussed at length in Section IX of the Minimum Standards of Design for Water Pollution Control Facilities, Kansas Department of Health and Environment.

POLICY

- A. The Bureau of Water Quality endorses the practice of effluent irrigation from municipal treatment systems where compatible with established water rights, water quality standards, and sound engineering concepts of cost-effective design.
- B. The following minimum levels of treatment and protection will be required for municipal effluent irrigation systems:

MINIMUM REQUIRED TREATMENT LEVEL

<u>PROJECTED USE OF EFFLUENT</u>	<u>SITE PROTECTION REQUIREMENTS</u>	
	<u>IRRIGATION ORIENTED (Periodic Discharge to Surface Waters)</u>	<u>TREATMENT ORIENTED (No Discharge to Surface Water)</u>
Athletic fields, highway rest areas, or public parks with a high probability of body contact.	Secondary Treatment ¹ Filtration Disinfection	Secondary Treatment ¹ Filtration Disinfection 90 Days Storage ⁴
Golf courses or public parks with low probability of body contact.	Secondary Treatment ¹ Disinfection	Secondary Treatment ¹ Disinfection 90 Days Storage ⁴
Airfields, farmland, and other properties owned or leased by the municipality.	Secondary Treatment ¹	Primary Treatment 90 Days Storage ⁴
Farmland and properties not owned leased by the municipality.	Secondary Treatment ¹	Primary Treatment 90 Days Storage ⁴

¹ Secondary treatment includes effluent from approved lagoon systems when withdrawn from the final cell above the two foot operational level.

² Use of treated effluent to cool golf greens during playing hours is prohibited. Consideration should be given to using a potable water connection to the golf course irrigation system for green cooling purposes or use of a portable water tank. Suitable backflow prevention measures must be incorporated into the design to prevent backflow or siphonage into the potable water system. The effluent irrigation system must be drained prior to connection with any potable water source.

³ Irrigation oriented systems shall provide tailwater management or facilities unless applied runoff meets permit effluent limitations and would directly enter a defined water course.

⁴ Volume of the secondary treatment cell, above the 2 foot level, of a lagoon system may be utilized for storage.

- C. Treatment oriented irrigation systems must provide adequate storage capacity for wastewater flows during periods when irrigation activities cannot be conducted. In any event, not less than 90 days storage, based on average design flows, following primary treatment shall be provided.
- D. Tailwater control management or facilities are recommended for irrigation oriented systems, and are required for treatment oriented systems to prevent discharge into surface waters.
- E. Municipal wastewater effluents used for irrigation shall not be applied at rates in excess of acceptable soil infiltration rates and/or the nutrient or moisture requirements of proposed crops. Kansas State University Extension Service and other agencies should be consulted to evaluate application rates. See Section IX, Minimum Standards of Design for Water Pollution control Facilities for additional discussion.
- F. Unless energy or labor intensive, existing treatment facilities should be utilized to pretreat primary effluent prior to irrigation or storage for treatment oriented systems. Effluent storage reservoirs are to be designed and maintained such that nuisance conditions do not develop.
- G. Monitoring and Reporting Requirements:

The permit holder will be required to maintain accurate records, recording the date, place, and quantity of effluent applied, and to make such records available for inspection by the Bureau of Water Quality. Groundwater and surface water monitoring records may be required to be maintained and submitted. Section IX, Minimum Standards of Design discusses various parameters that may require groundwater monitoring. In general, monitoring and reporting requirements will be determined on a case by case basis and will be stipulated in the compliance and reporting section of the permit.

H. Cross Connections:

Any connection between wastewater effluent irrigation piping and/or equipment and a potable water system or groundwater irrigation well which would allow backflow of effluent into the system or well is strictly prohibited.

- I. If there is reasonable certainty that toxic materials might be present in the wastewater, a complete laboratory analysis shall be required prior to implementation of the project.

10 April 1978
Date

Eugene T. Jensen
Eugene T. Jensen, P.E., Director
Bureau of Water Quality

CONSTRUCTION GRANT
PROJECT BYPASS PROCEDURE

PURPOSE:

To revise the formal bypass procedures set out in Item 5, Part II Administrative Procedures of the Kansas Project Priority System for Construction Grants to conform to the requirements in Paragraph 5 of the EPA Program Requirements Memorandum (PRM) #78-13 and 40 CFR 35.915 (d) and (f)(1).

BACKGROUND:

The Clean Water Act of 1977 (P.L. 95-217) and the revised Title II Regulations make it necessary to slightly revise the procedures for the management of the Kansas project priority list. Although readiness for funding may not be used as a priority criterion for rating or ranking projects, the ability to bypass projects not yet ready to proceed according to schedule is an essential part of priority list management.

The Kansas priority system as adopted July 14, 1977, provides in Part II, Item 5 that "The Secretary, Kansas Department of Health and Environment, may from time to time amend either priority sublist to include a project(s), certified by the Kansas Department of Health and Environment, Bureau of Water Quality, and agreed to by the Regional Office of the Environmental Protection Agency, as needed to protect the public health, meet emergency law, or allocations. The Secretary may also amend either priority sub-list to bypass a project(s), certified by the

Kansas Department of Health and Environment, Bureau of Water Quality, and agreed to by the Regional Office of the Environmental Protection Agency, as not ready for step funding before the end of the current allotment period for a lower priority project(s) providing the bypassed project(s) be reinstated at a relative priority for future funding consistent with water quality management plans approved by the State of Kansas and the Environmental Protection Agency. The Secretary will give public notice of his intent to amend or modify the list and will hold a public hearing if there is an expression of public concern".

POLICY:

The Bureau of Water Quality will observe the following policy with respect to use of the Project Bypass Procedures as set out in Part II, Item 5, administrative procedures of the Kansas Project Priority System for Construction Grants:

1. The project bypass procedure will be applied to the fundable portion of the priority list.
2. The municipality will, as a part of the public notice, be advised the Bureau of Water Quality has determined that the project to be bypassed will not be ready to proceed during the funding year.
3. Bypassed projects shall retain their relative priority rating for consideration in future year allotments.
4. The highest ranked project(s) on the planning portion of the list will replace the bypassed project(s).

2 November 1973
Effective date

Eugene J. Deen
Director, Bureau of Water Quality

KANSAS WATER POLLUTION CONTROL PERMIT APPLICATION PROCEDURES

PURPOSE

To clarify the Bureau of Water Quality's position with respect to submission of discharge permit applications and plans and specifications for wastewater treatment facilities.

BACKGROUND

The Kansas Division of Environment currently administers a State wastewater discharge permit program under the authority of Kansas Statute 65-165. The State permit program has been accepted by the Environmental Protection Agency as satisfying the requirements of Section 402 of Public Law 95-217, the National Pollutant Discharge Elimination System. Wastewater discharge permits set forth the required level of treatment to be provided if the permitted discharge is to comply with appropriate law and regulations. These statutes require, as a minimum, that all dischargers of domestic sewage from publicly-owned treatment works provide "secondary treatment", with more stringent treatment required where necessary to meet water quality standards. Hydrographic conditions in some Kansas streams and lake watersheds, notably in urban areas, are such that some dischargers will be required to meet effluent limitations more stringent than the Environmental Protection Agency's definition of secondary treatment to provide adequate protection for the public health.

Kansas Administrative Regulation 28-16-61 requires the Kansas Division of Environment to place all proposed or modified discharge permits on Public Notice for a period of 30 days before a final permit can be issued. If there is significant public opposition or interest in the proposed permit during the Public Notice period, a hearing must be held to receive input from concerned citizens and agencies. Based upon evidence presented at the Public Hearing, the Division of Environment would make a decision either to issue or deny the permit application.

Current Department regulations and policies are not totally clear concerning the timing of submittal of discharge applications and plans and specifications. Kansas Statute 65-166 requires "That upon making application for a permit to discharge sewage into any waters of the State, . . . the application shall be accompanied by plans and specifications for the construction of the sewage collection systems and/or sewage treatment or disposal facilities, and any additional facts and information that the State Board of Health may require." Kansas Administrative Regulation 28-16-2, Submission of Information, requires that "Plans, specifications, report and application must be submitted to the Chief Engineer for the Board at least three weeks prior to the date on which action is desired." This statute and regulation have been interpreted in the past to require detailed plans and specifications to be prepared and submitted to the Division of Environment along with any application for a sewage discharge permit.

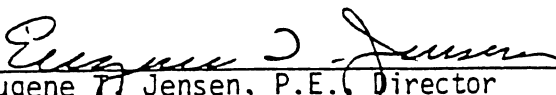
Division policy on this subject includes two requirements found in the State of Kansas, Department of Health and Environment, "Minimum Standards of Design for Water Pollution Control Facilities". Chapter I, Facilities Plan, Section G.2.

states that engineering reports (facilities plans) should contain an identification of effluent discharge limitations for existing treatment works as delineated by NPDES permits. Chapter IV, General Design for Sewage Treatment Works, Paragraph B, states that the design engineer should obtain this information (degree of treatment required) prior to preparation of an engineering report.

The Kansas Water Quality Management Plan also controls the location of treatment plants through identified service areas for communities. Section 208(e) of the Clean Water Act prohibits the issuance of a discharge permit unless in conformance with the plan. The following policy is offered to clarify the Kansas Division of Environment's position on submission of plans and specifications and discharge permit applications:

Policy

1. New wastewater treatment plants, located on previously unpermitted sites: It is recommended that detailed design of new wastewater treatment facilities not begin until after a Kansas Water Pollution Control Permit has been drafted, placed on Public Notice, and a determination made that a public hearing will not be necessary. The application for a wastewater discharge permit should be accompanied by sufficient information about location and design of the proposed treatment facilities so that site-specific effluent limitation determinations can be made and a draft permit prepared. Conformance with the Kansas Water Quality Management Plan should also be addressed in the permit application submittal.
2. Improvements or expansions of existing permitted treatment facilities: It is recommended that detailed design of improvements or expansions to existing treatment facilities not begin until after the Bureau of Water Quality has made a determination of the degree of treatment to be required. Sufficient information concerning the design population to be served should be furnished so that water quality criteria requirements can be considered.
3. Non-overflowing or total retention facilities do not require a Public Notice period prior to State permit issuance. However, Department clearance is strongly recommended prior to design. Prior to Department clearance the Department reviews the proposal for compliance with the State Water Quality Management Plan, technical environmental considerations, and approval by local government.


Eugene T. Jensen, P.E., Director
Bureau of Water Quality
Kansas Department of Health & Environment



DEPARTMENT OF HEALTH AND ENVIRONMENT

Policy Memorandum 87-6
April 1987

A handwritten signature in dark ink, appearing to read "Gyula F. Kovach", written over the typed name.

FROM: Gyula F. Kovach, P.E.
Manager, Bureau of Water Protection

SUBJECT: CONSTRUCTION ALTERNATIVES TO CONVENTIONAL SANITARY SEWER SYSTEMS

PURPOSE:

To establish the Bureau of Water Protection's policy regarding approval of nonconventional alternatives to standard gravity sanitary sewage collection systems. This policy explains when the Bureau of Water Protection will consider nonconventional sanitary sewer collection systems, and what conditions must be satisfied before nonconventional sanitary sewer systems will be approved.

BACKGROUND:

Historically, sanitary sewage service in Kansas has been provided through construction of eight-inch minimum diameter gravity sewer lines with pump stations provided as necessary. Increased interest in alternative sewer collection systems is being expressed in Kansas as an alternative to the traditional eight-inch gravity line approach to sanitary sewage service. The Kansas Department of Health & Environment's Minimum Standards of Design for Water Pollution Control Facilities, adopted pursuant to K.S.A. 65-171h, address pressure sewer collection systems briefly in Chapter 6, Sanitary Sewer Design. The minimum standards state that "Pressure sewer collection systems may be utilized where adequate justification is given for their use. The entity with responsibility for maintaining the system must demonstrate it has the capability and manpower to operate and maintain the system."

Conventional sanitary sewer design, due to its proven technology, simplicity, energy efficiency, and ease of operation and maintenance, is the accepted method of approach for providing sanitary sewage service to Kansas communities and new developments. However, the Department recognizes there are unusual circumstances which may require consideration of alternative technology such as septic tank effluent pump systems, pressure sewer systems, variable grade sewers, and use of grinder pumps as alternatives to conventional gravity sewer systems. The circumstances include industrial applications; end line usage; post sewer construction basement service; unusually deep basement service; low population density; poor soil conditions; high groundwater elevation; and, rocky or hilly terrain. Initial cost savings realized with installation of alternative sewer systems must be compared with additional operation and replacement costs inherent

with the more sophisticated, maintenance-intensive alternative systems, and the capability of the owner to operate and maintain the system must also be demonstrated. KDHE's review will encompass these areas and approval will not be provided unless the Department is assured the application of alternative technology is appropriate to the requested sewerage service.

POLICY:

Bureau of Water Protection approval for alternative sewer systems will be considered only when the present worth cost difference of conventional sewers and nonconventional sewers is significant, and if the responsible entity can demonstrate it has the financial, legal and organizational capability and manpower to operate and maintain the system. The entire nonconventional system shall be publicly owned and operated with appropriate right-of-ways for maintenance, repair and replacement.

The present worth cost comparison must include capital cost provisions for spare pumps and parts, system failure detection, maintenance costs, standby equipment costs, right-of-way costs, and other costs as appropriate. For the purposes of this comparison, the design life of conventional sanitary sewer systems shall be considered 50 years, the design life of conventional pump stations shall be considered 20 years, while the design life of either grinder pumps or individual household pumping units shall not exceed 10 years. The sewage piping for the individual household units may also have a lifetime of 50 years.

Information provided to KDHE to address the capability of the responsible entity to operate and maintain the system shall include provisions for routine and emergency maintenance; right of access for repairs and maintenance; an assessment of man-hour requirements and availability; an assessment of standby equipment needs; an assessment of emergency operation including power failure, component malfunctions and emergency operating procedures; and a proposed method of sewer charges to address these items. A statement by the responsible public entity requesting approval of the alternative technology must be submitted indicating it is committed to providing the increased attention to maintenance necessary to assure a continuously operating system and to maintaining a sufficient spare parts inventory. Further proof of public ownership for the entire nonconventional system shall also be submitted with all other technical and nontechnical information. The contractor shall be required to furnish a two-year cash performance bond to the owner for 100% of the system cost in the event of system failure. The owner must submit assurances a conventional system will be constructed within one year of system failure, and must provide KDHE a performance certification at the end of the two-year period.



State of Kansas

Mike Hayden, Governor

Department of Health and Environment Division of Environment

Stanley C. Grant, Ph.D., Secretary

Forbes Field, Bldg. 740, Topeka, KS 66620-0002

(913) 296-1535

FAX (913) 296-6247

Policy Memorandum #90-2
September 1990

FROM: Karl W. Mueldener, P.E.
Director, Bureau of Water

SUBJECT: INDUSTRIAL WASTEWATER POND LINER POLICY

PURPOSE:

This document states the Bureau of Water (Bureau) policy for requirements relating to industrial wastewater ponds. This policy is intended to protect the water and soil resources from a significant risk of contamination posed by earthen lagoons utilized for the containment/treatment of industrial wastewater and to provide minimum standards for the design and construction of new industrial wastewater ponds and the retrofitting of existing earthen lagoons.

BACKGROUND:

The Bureau of Water administers the Kansas Water Pollution Control Permit program established by K.S.A. 65-164 and 65-165. Wastewater ponds which discharge to surface waters or total retention through the use of evaporation, irrigation or recycle are addressed by this program. The Department has responsibilities under K.S.A. 65-171d to prevent subsurface water pollution and soil pollution. An increased emphasis, at both the state and federal level, has been placed on addressing source control as a mechanism for preventing or minimizing groundwater contamination. Since groundwater contamination from earthen ponds has been documented, the Bureau concludes construction of new industrial wastewater ponds without impermeable liner/leak detection systems represent an unnecessary risk of polluting groundwater and soils.

POLICY:

Any new or modified wastewater ponds designed and constructed for the containment or treatment of industrial wastewater, for other than non-contact cooling water or conventional domestic-type wastewater shall meet the following requirements:

1. The pond shall have a primary and secondary liner with an intermediate leak detection system.
2. The primary liner shall be at least 30 mil in thickness.
3. The secondary liner shall also be at least 30 mil in thickness, or, depending on the situation, other alternatives may be approved on a case by case basis.
4. Compaction of the pond embankments and upper 12 inches of the interior bottoms below the secondary liner shall be a minimum of 95% of the maximum standard proctor density. The maximum thickness of the layers of material to be compacted shall be 6 inches. The moisture content range shall be optimum moisture to optimum moisture + 3%. The maximum size of dirt clods in the compacted soil shall be less than one inch diameter.

5. A minimum of two cells must be provided to allow flexibility in operation/maintenance of the pond system. This requirement may be waived if approved wastewater disposal options are available when the pond needs to be dewatered.
6. The primary and secondary liners shall be separated by a permeable material (clean sand or pea gravel having a particle size of less than 1/4 inch in diameter). At least ten (10) inches of sand shall separate the liners on the pond bottom and either six (6) inches of sand or a geotextile fabric shall separate the liners on the slopes.
7. A statement from the liner manufacturer shall be submitted stating the liner is UV resistant and compatible with the wastewater to be contained/treated.
8. A statement from the liner manufacturer shall be submitted stating the permeability of the liner in units of volume/area/time, e.g. gallon/square feet/day.
9. The leak detection pipe(s) shall be placed in a trench to enhance collection of leachate. There should be perforations in the pipe(s), preferably between the 4 or 5 o'clock and 7 or 8 o'clock positions. The pipe(s) shall be wrapped in geotextile fabric to prevent plugging of openings in the pipe(s) by the fine granular material placed between the liners.
10. The pond bottom shall have at least a 2.5% slope to the leak detection pipe(s). The leak detection pipe(s) shall have at least a 1.0% slope to an observation pipe, sump, manhole or other similar structure.
11. The primary and secondary liners shall be anchored at the top of the dike. The liners shall overlap the dike in a U or L-shaped fashion and then be backfilled with soil.
12. The liner shall be installed in accordance with the liner manufacturer's recommendations and by a contractor experienced in synthetic liner installation (at least 10 million square feet of liner previously installed by the contractor is recommended). It is recommended the liner installation be supervised by a representative of the liner manufacturer.
13. A reliable seam testing method shall be used to verify there are no leaks in seams or seals. The methods of destructive and non-destructive seam testing shall be specified. The number destructive tests per linear foot of field seam, and the size of the destructive test specimens shall be specified. All field seams shall be subjected to non-destructive testing.
14. The Kansas Minimum Standards of Design for Water Pollution Control Facilities shall be followed for compaction requirements, slopes, embankment top width, freeboard and any other general wastewater pond construction criteria.

These liner requirements are not applicable for the containment/treatment of hazardous wastes. The Department's Bureau of Air and Waste Management-Hazardous Waste Section should be contacted for hazardous waste requirements.

EFFECTIVE DATE:

The above policy will be in effect on September 18, 1990, and will remain in effect until withdrawn, revised, or modified by the Director.



State of Kansas

Mike Hayden, Governor

Department of Health and Environment Division of Environment

Stanley C. Grant, Ph.D., Secretary

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WATER QUALITY POLICY MEMORANDUM

Policy Memorandum 90-4
November 7, 1990

FROM: Karl Mueldener, P.E.
Manager, Bureau of Water

SUBJECT: Kansas Department of Health and Environment
Combined Sewer Overflows

PURPOSE:

To establish the Bureau of Water policy regarding the permitting of Combined Sewer Overflows (CSO). This policy explains the permitting process, the information to be provided by the wastewater treatment authority, the public health and water quality concerns, and some of the remedial measures available to resolve adverse impacts of combined sewer overflows.

BACKGROUND:

Municipal sanitary sewage and stormwater runoff were sometimes collected in one interceptor for transport and discharge. More recently, construction of separate storm and sanitary sewer systems have been the norm in Kansas and many portions of existing combined sewers have been "separated". However, several cities maintain combined systems with discharge of raw sewage and stormwater during runoff events. The Kansas Department of Health and Environment (KDHE) recognizes the need to insure the protection of public health and water quality of streams receiving combined sewer overflows, and recognizes the potential adverse public health and water quality impacts of CSO discharges. The Policy sets forth three main objectives of KDHE in review of potential CSO problems:

1. To ensure that all CSO discharges occur only as a result of wet weather.
2. To bring all wet weather CSO discharge points into compliance with the technology based requirements of the Clean Water Act and applicable Federal and State regulations including Kansas Water Quality Standards.
3. To minimize water quality, aquatic biota, and human health impacts from wet weather overflows.

KDHE has responsibility to ensure that proper wastewater treatment is provided to protect water quality of the streams within the State and protect the public health of the citizens of Kansas. KDHE administers the NPDES permit program. EPA and KDHE have focused attention on a uniform and defined policy for CSO's. Considering these responsibilities, KDHE developed this state-wide strategy for combined sewer overflows.

POLICY:

KDHE shall address CSO's in the NPDES permit for the treatment plant serving the general CSO area. The NPDES permit requirements will conform to the strategy described herein.

STRATEGY:

The following describes the Bureau strategy in implementing the CSO policy:

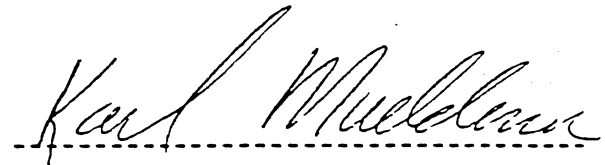
- 1) The permitted utility shall confirm the location of combined sewer overflows. A "Field Check" to verify locations is required. The physical location of the discharge point and a description of the overflow mechanism and means of operation is required. If raw dry weather sanitary discharges are located, these must be immediately reported to KDHE and action undertaken to eliminate the discharge. The utility must certify to KDHE there are no raw dry weather sanitary discharges or provide a schedule for their elimination.
- 2) A "Flow Study" of the sewer system shall be completed to estimate quantities of the rate, volume, frequency, duration, and pollutant content of the overflows. This study shall describe the sanitary sewer upstream from the CSO including an estimate of the quantity of domestic wastewater, and estimates of the type and quantity of industrial wastewaters which could potentially discharge through the overflow points. A description of the upstream area storm water drainage sewer system must be provided including estimates of land use (i.e., percentage area in streets and parking lots, percentage area of buildings, percentage area in industrial parks, percentage area of open spaces and green spaces, etc.). An estimate of peak flow rates and type and volume of non-point source pollutants discharged through the outfall must be developed. An estimate of the peak sanitary flow generated within the sanitary sewer collection system compared to the peak flow capability of the combined system without overflow is required.
- 3) With development of the above report, the utility will be required to develop a "Management Report" addressing the following potential CSO controls in an effort to reduce CSO impacts:
 1. A regular maintenance program for the sewer system and the combined sewer overflow points, and an operating plan to reduce CSO volumes;
 2. Use of the collection system for maximum storage;

3. Review of pre-treatment programs to determine if modifications will minimize CSO impacts;
4. Maximization of flow to the POTW for treatment. A review of the maximum flow handling capability of the treatment plant will be necessary;
5. Control of solid and floatable materials in CSO discharges.

The utility must determine the level of effort and estimated costs to satisfy the potential CSO controls established by this policy. KDHE will allow utilities no more than 12 months to obtain the above referenced information and produce the reports for submittal to KDHE, required as conditions of NPDES permits. Following completion of the referenced reports and review by KDHE, KDHE will meet with the appropriate utility to discuss the results of the reports and future required actions.

Following receipt and review of the reports and necessary meetings, a water quality impact study to assure compliance with KDHE Water Quality Standards may also be required. If an adverse water quality impact directly attributable to the combined sewer overflows is indicated, additional control measures must be considered. These may include:

1. Additional pre-treatment program modifications including local limits program modifications.
2. Identification of illegal discharges with elimination and/or updating of sewer use ordinances.
3. Monitoring requirements which may include pollutant specific limitations.
4. Reduction of combined sewer overflow volumes through flow minimization or hydraulic capacity improvements, sewer rehabilitation, in-line and off-line storage, sewer separation, or construction of CSO controls within the sewer system or at the CSO discharge point.
5. Direct treatment of overflows by construction of new or modified wastewater treatment facilities.



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